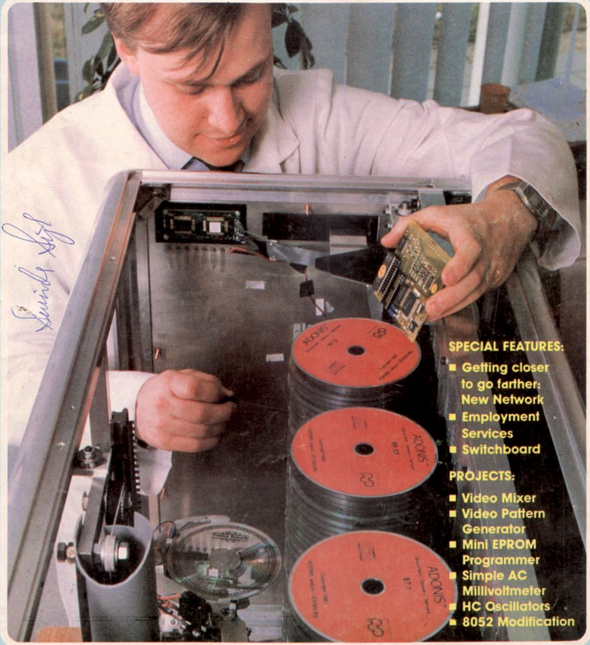
ISSN 0970-3993

82
February
1990

elektor INDIA electronics

Rs. 10.00



SPECIAL FEATURES:

- Getting closer to go farther: New Network
- Employment Services
- Switchboard

PROJECTS:

- Video Mixer
- Video Pattern Generator
- Mini EPROM Programmer
- Simple AC Millivoltmeter
- HC Oscillators
- 8052 Modification

Volume-8 Number 2
February-1990

Publisher: C.R. Chandarana
Editor: Surendra Iyer
Circulation & Advtg: J. Dhas
Production: C.N. Mithagari
Advertising: Punam T. Bhatt

Address:
ELEKTOR ELECTRONICS PVT. LTD.
52, C Proctor Road, Bombay-400 007 INDIA
Telex: (011) 76661 ELEK IN

OVERSEAS EDITIONS

Elektor Electronics (Publishing)
Down House, Broomhill Road,
LONDON SW18 4JQ
Editor: Len Seymour

Elektor sarl
Route Nationale; Le Seau; B.P. 53
59270 Bailleul – France
Editors: D R S Meyer;
G C P Raedersdorf

Elektor Verlag GmbH
Süsterfeld-Straße 25
5100 Aachen – West Germany
Editor: E J A Krempelsauer

Elektor EPE
Karaiskaki 14
16673 Voula – Athens – Greece
Editor: E Xanthoulis

Elektuur B.V.
Peter Treckpoelstraat 2-4
6191 VK Beek – the Netherlands
Editor: P E L Kersemakers

Electro-shop
35 Naseem Plaza
Lasbella Chawk
Karachi 5 – Pakistan
Manager: Zain Ahmed

Ferreira & Bento Lda.
R.D. Estefania, 31-1°
1000 Lisboa-Portugal
Editor: Jeremias Sequeira

Ingelek S.A.
Plaza República Ecuador
2-28016 Madrid – Spain
Editor: A M Ferrer

Electronic Press AB
Box 5505
14105 Huddinge – Sweden
Editor: Bill Cedrum

The Circuits are domestic use only. The submission of designs or articles implies permission to the publisher to alter and translate the text and design and to use the contents in other Elektor Publications and activities. The publishers cannot guarantee to return any material submitted to them. Material must be sent to the Holland address (given above). All drawings, photographs, printed circuit boards and articles published in elektor publications are copyright and may not be reproduced or imitated in whole or part without prior written permission of the publishers.

Patent protection may exist in respect of circuit devices, components etc. described in this magazine.

The publishers do not accept responsibility for failing to identify such patent or other protection.

MEMBER

Printed at : Trupti Offset Bombay - 400 013

Copyright © 1990 Elektuur B.V.

CONTENTS

Special Features

Getting closer to go farther:
New Network 2.09

Components

HCMOS oscillators 2.45

Computers

PROJECT: EPROM programmer 2.14
PROJECT: CMOS RAM contral for PC/AT 2.33
PROJECT: CMOS replacement for 8052 AH-BASIC 2.42

General Interest

PROJECT: The digital model train Part-10 .... 2.27
Safety first 2.52

Radio & Television

PROJECT: Video mixer Part 1 .... 2.22
PROJECT: Video pattern generator 2.48

Science & Technology

Conversing with computers-naturally 2.39

Test & Measurement

PROJECT: Simple AC millivoltmeter 2.18
PROJECT: 1 GHz frequency meter card for PCs 2.35

Information

Employment Services 2.60
New products 2.58

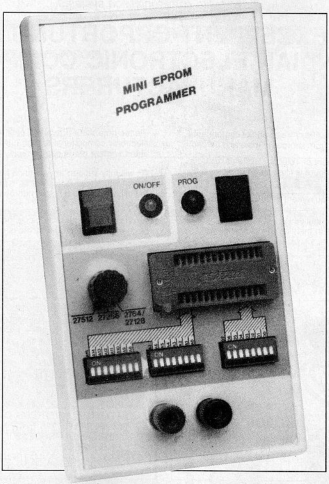
Guide lines

Switch board 2.57
Classified ads 2.66
Index of advertisers 2.66

MINI EPROM PROGRAMMER

J. Ruffell

Many constructors have good reasons for preferring a low-cost EPROM programmer with manual data and address to a full-blown programmer operating under computer control. First, they may not have a computer; second, they do not mind spending some time on programming small amounts of data; and third, they object to the expenditure on an instrument that is only occasionally called upon.



The programmer is definitely not intended for loading huge amounts of data into EPROMs. Even if you could manage to program bytes faultlessly at a rate of one per second, it would take more than 18 hours to load all 65,536 bytes (64 Kbytes) in a Type 27512 EPROM, the largest the present programmer can handle. Moreover, it is a common misunderstanding to associate EPROMs with microcomputer systems that require large amounts of data. As has been shown in a number of projects in this magazine over the past few months, there are quite a few occasions where no more than, say, 256 or 512 bytes are involved, such as where EPROMs function as programmable look-up or conversion tables.

Although the circuit diagram of the mini EPROM programmer (Fig. 1) looks crowded, it should be noted that most components go into the power supply to ensure that the high programming voltage is not applied to the EPROM until the 5 V supply voltage is present — the reverse sequence would have disastrous consequences. Also note that an EPROM must never be removed from the working programmer, because the order in which the programming voltage and the supply voltage are removed might just be wrong.

How it works

Although the supply circuit already looks quite crowded in places, it is not complete without an external regulated power supply to furnish the programming voltage plus about 750 mV. The input voltage to the circuit may be adjusted by measuring the programming voltage at point Pv. The programming voltage is determined by the EPROM type and its manufacturer. Regulator IC_3 reduces the programming voltage to 5 V which is used to power the EPROM and the programmer circuit. Transistor T_1 prevents the programming voltage being applied to the EPROM before the 5 V supply voltage. The transistor is controlled by a monostable multivibrator (MMV), IC_{1a}. After this has been triggered, its Q output remains high until it is reset via its $\overline{CLR}$ input. This input is connected to the rest of the circuit in a manner to ensure that IC_{1a} is reset if the +5 V supply voltage disappears, or when there is no supply voltage at all. The latter condition may appear superfluous, but the programming voltage is immediately disconnected from the relevant EPROM pin when the programmer is switched off with S_1. The 5 V supply voltage, however, remains present for a short while because the electrolytic capacitors take some time to discharge. Conversely, IC_{1a} can not be set until the +5 V supply voltage is present. The SET input of the MMV is formed by trigger input B, which is connected to network R_3-C_5. The voltage on C_5 takes a few seconds to rise to a level that enables IC_{1a} to be set, and, consequently, the programming voltage to be applied to the EPROM. Capacitor C_{10} is required only if the $\overline{CLR}$ input of IC_{1a} is erroneously actuated by input voltage fluctuations. The value of C_{10} should be between 100 pF and 10 nF and must be determined empirically. In general, the capacitor must be kept as small as possible.

Bi-colour LED D_7 indicates the status of the EPROM programmer. The LED turns red (T_3 off; T_4 on) if the 5 V supply voltage is present, and green if both the 5 V and the programming voltage are present.

The circuit around IC_{1b} (also a MMV) is a programming pulse generator. When S_2 is actuated, a single 50-ms programming pulse is generated. An intelligent programming algorithm with variable programming pulse length is, of course, not feasible in a simple circuit like this. Even if it were available, the total programming time would not be reduced because the data and addresses are set manually, which takes much longer than 50 ms in any case.

The bulk of the signals in the programmer circuit emanates from DIP switches and associated pull-up resistors. Addresses are set with S_4 and S_5, data with S_6. Switch S_3 is used to select the EPROM type. The connections it makes are in ac-

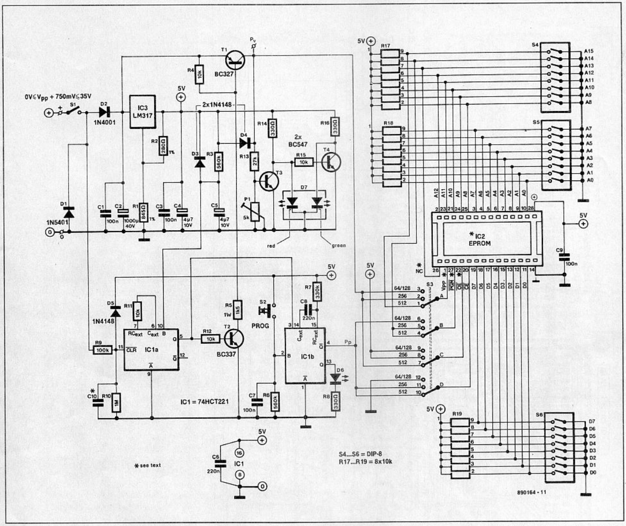


Fig. 1. Circuit diagram of the budget EPROM programmer, the larger part of which consists of the power supply with automatic Vpp delay.

cordance with the EPROM data listed in Table 1.

Construction

The printed-circuit board for the programmer is shown in Fig. 3. Start the construction by fitting the wire links. Next, fit the resistors and capacitors. Each of the three single-in-line (SIL) resistor arrays may be replaced by eight vertically mounted, discrete resistors whose upper terminals are cut short and commoned by a horizontal wire that goes into the hole provided for the +5 V connection of the array.

The semiconductors are fitted next, with the exception of the LEDs. IC3 does not need a heat-sink, and is bolted straight on to the PCB. Mount rotary switch S3, but do not cut its spindle as yet.

Be sure to mount the components that protrude from the front panel at the correct height above the board. This involves the LEDs, on/off switch S1, programming switch S2, the data/address DIP switches and the ZIF (zero-insertion force) socket

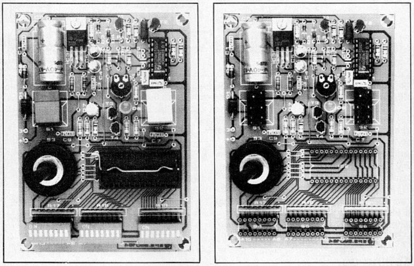


Fig. 2. As shown on these photographs of the assembled PCB, IC sockets are perfect for mounting the push-buttons and the DIP switch blocks. SIL strips are used for the ZIF socket. The height of the prototype enclosure did not require low-profile IC sockets to be stacked.

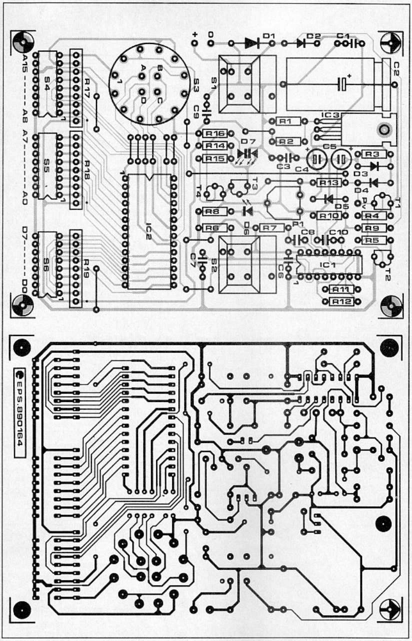


Fig. 3. Track layout and component mounting plan of the single-sided PCB for the mini EPROM programmer. Start the construction with fitting the wire links.

Parts list

Resistors:
R_1 = 845Ω; 1%
R_2 = 280Ω; 1%
R_3;R_6 = 560k
R_4;R_{11};R_{12} = 10k
R_5 = 1k5; 1 W
R_7 = 330k
R_8;R_{14};R_{16} = 330Ω
R_9 = 100k
R_{10} = 1M0
R_{13} = 27k
R_{15} = 10k
R_{17};R_{18};R_{19} = 8-resistor; 9-pin SIL resistor array 10k
P_1 = 5k preset H

Capacitors:
C_1;C_3;C_7;C_9 = 100n
C_2 = 1000µ; 40 V
C_4;C_5 = 4µ7; 10 V; radial
C_6;C_8 = 220n

Semiconductors:
D_1 = 1N5401
D_2 = 1N4001
D_3;D_4;D_5 = 1N4148
D_6 = LED
D_7 = 3-terminal bi-colour LED
T_1 = BC327
T_2 = BC337
T_3;T_4 = BC547
IC_1 = 74HCT221
IC_2 = EPROM to be programmed
IC_3 = LM317

Miscellaneous:
S_1 = self-locking push-button; ITW Type 61-20204000 +.
S_2 = momentary action push-button; ITW Type 61-10204000 +.
S_3 = PCB-mount 4-pole 3-way rotary switch.
S_4;S_5;S_6 = 8-way DIP switch block.
28-way IC socket (ZIF type preferred).
PCB Type 890164

for the EPROM. A good way of achieving the correct height for the DIP switches is to use wire-wrap sockets or simply three or four stacked low-profile IC sockets (see Fig. 2). Much depends on the enclosure used.

Figure 4 shows a suggested lay-out for the front panel of the programmer. Make a photocopy of this drawing and use it as a template to cut and drill the metal or ABS front-panel of your enclosure.

Setting up

Connect the external power supply and adjust it to an output that results in +10.0 V at point Pv (you may have to wait

Pin	2764	27128	27256	27512
1	Vpp	Vpp	Vpp	A15
22	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$/Vpp
26	n.c.	A13	A13	A13
27	PGM	PGM	A14	A14

Signal	2764	27128	27256	27512
$\overline{OE}$	H	H	H	
$\overline{OE}$/Vpp				Pv
Vpp	Pv	Pv	Pv	
$\overline{CE}$	L	L	⊔	⊔
$\overline{PGM}$	⊔	⊔		

Table 1. EPROM programming data as set by the EPROM type switch on the front panel.

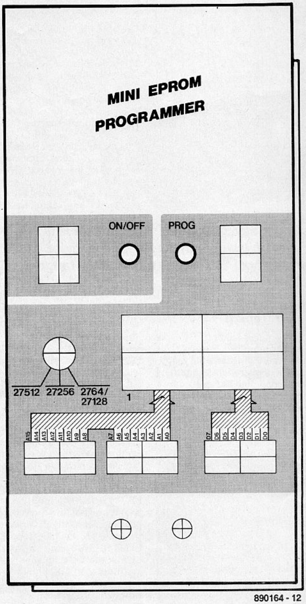


Fig. 4. Suggested front-panel layout shown at true size for easy reproduction.

a second or two until T_1 is turned on). Adjust P_1 until the status LED changes colour. This completes the adjustment procedure.

Do's and don'ts

There are a few basic rules to keep in mind when using the mini EPROM programmer:

- Before inserting an EPROM, always check the programming voltage at point Pv and adjust your power supply to set the correct value for the device to be programmed. Next, set the EPROM type on S_3.
- Never insert or remove an EPROM with the programmer switched on.
- And, finally, *think* before actuating the programming switch!

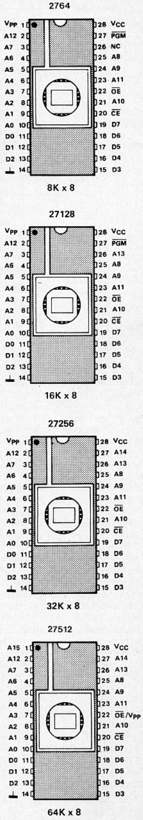


Fig. 5. Pin-outs of the four members of the 27xxx family that can be programmed.

SIMPLE AC MILLIVOLTMETER

The third instrument in our series on budget test equipment is a wideband millivoltmeter with no fewer than twelve ranges, quite reasonable accuracy, a sensitivity of 200 µV and a frequency range from 20 Hz to over 2 MHz.

T. Giffard

A sensitive AC millivoltmeter is a useful instrument even if an oscilloscope is already available in your electronics workshop. This is mainly because signal levels are easier read from a meter scale than from an oscilloscope screen, which requires counting graticule divisions, multiplication by the set sensitivity, and conversion from the peak-to-peak value to the rms (root-mean-square) value. The AC millivoltmeter is also smaller and more sensitive than the average oscilloscope, and in addition may be powered by batteries. Compared to the digital multimeter, the AC millivoltmeter offers a much greater bandwidth. Although hard to beat for DC measurements, most DMMs have a frequency range of just 400 Hz which makes them really unsuitable even for signal tracing and frequency response measurements in AF amplifiers. By contrast, the AC millivoltmeter has a bandwidth of 20 Hz to 2 MHz.

The test instrument described here has no fewer than 12 measurement ranges from 0.2 mV to 60 V, and a high input impedance of 1 MΩ. The highest range, 60 V, allows output voltages of powerful AF amplifiers to be measured, while the most sensitive range, 0.2 mV, is suitable for direct signal level measurements on microphones and pick-up cartridges.

The choice of the enclosure and the design of the front-panel of the AC millivoltmeter are in line with the two earlier described instruments.

Circuit description

Since the instrument measures AC voltage only, off-set and drift are not normally problems in the amplifier stages. This means that integrated differential amplifiers in the form of operational amplifiers are not needed, and may be replaced by a circuit based on discrete transistors. The final version of this circuit was found to offer good stability at a reasonable bandwidth by virtue of the accurately compensated voltage divider at the input, and a PCB design that prevents problems with wiring capacitance by accommodating the range switch on the printed-circuit board.

SIMPLE AC MILLIVOLTMETER

AV measurement ranges:

0.2 mV; 2 mV; 20 mV; 200 mV; 2 V; 20 V
0.6 mV; 6 mV; 60 mV; 600 mV; 6 V; 60 V

Accuracy:

- approx. 5% at 2 MHz with selected compensation capacitors in input attenuator; approx 3% at 100 kHz (depending on meter error).
- approx. 2% at 15 kHz; 10% above 15 kHz with non-selected standard MKT capacitors in input attenuator.

Bandwidth (0.5 dB):

17 Hz to 2 MHz

Input impedance:

1 MΩ//10 pF

Battery voltage:

nominal:	9 VDC
maximum:	10 VDC
minimum:	7.5 VDC

Current consumption:

7.5 mA typ. at 9 V.

Voltage divider

The circuit diagram in Fig. 1 shows frequency compensation capacitors fitted in parallel with every resistor in the input attenuator around rotary switch S_1. These capacitors linearize the frequency response above 500 kHz. Ceramic capacitors are connected in parallel with larger MKT (metallized multi-layer theraphtelate) types as a fine correction to the compensation at relatively high frequencies. If possible, the ceramic capacitors are selected to give a time constant of 11 µs for each of the *R-C* combinations in the voltage divider.

Input amplifier

Depending on the position of S_2 in the measurement amplifier, the AC voltage at the gate of FET T_1 that results in full-scale deflection of the meter is either 0.2 mV or 0.6 mV. The gate of the FET forms a very high impedance so that the voltage divider is hardly loaded. Components D_1-D_2 and R_8 protect the gate against overvoltage. Diodes D_1 and D_2 conduct at gate voltages of about +9.6 V and −0.6 V respectively and afford protection to about 50 V in the 0.2 mV range. Capacitor C_{13} prevents R_8 and its associated stray capacitance (the FET, the diodes and the relevant PCB tracks) forming a low-pass filter that would limit the bandwidth of the millivoltmeter. It should be noted, however, that the reactance of C_{13} drops with increasing frequency, which reduces the protective effect of the diodes at frequencies above 40 kHz or so. The values of R_8 and C_{13} are, therefore, a compromise between bandwidth and protection over a reasonable frequency range.

FET T_1 is not included in the feedback circuit of the measurement amplifier that follows it. It has its own feedback resistor, R_{11}, to give an amplification of about 1.5 times. R_9 functions as a drain resistor for direct voltage only. For alternating voltages, it is decoupled by C_{15} and C_{16}. These parts decouple the supply voltage and so help to stabilize the sensitive input stage. The DC setting of the FET is determined by the source resistor: since the gate is effectively grounded by the resistor ladder network, the voltage drop across the source resistor creates a negative gate voltage (U_{GS}), which determines the current through the drain- and the source resistors. The resultant bias setting can be deduced from the curves in Fig. 2. For a drain voltage of about +5.5 V, R_{11} = 680Ω to set a drain current of about 1.5 mA at U_{GS} = 1 V. It should be noted, however, that FETs in the same I_{DSS}-U_p group (here, the A-type of the BF256 is used) are subject to a certain production tolerance. Fortunately, this is of little consequence in this case because of the low drive level (below 1 mV).

Measurement amplifier

This consists of a differential amplifier, T_2-T_3, followed by a class-A output amplifier. The emitter current of the differential amplifier is sunk by current source T_4, which uses a LED, D_3, to supply a reference voltage of 1.8 V. A normal red LED has a typical voltage drop of about 1.5 V and can not be used in this application. The LED required is either a high-efficiency or an amber type which drops typically 1.8 V.

With R_{13} = 1 kΩ, T_4 sinks a constant current of 1.2 mA. The output stage also uses a constant current source, T_6. This current source forms a high AC resistance at the collector of T_5. Compared to a single collector resistor, the current source allows a much higher gain to be achieved. The previously mentioned reference voltage source, D_3, is also used for this second current source to give a constant current of about 2.5 mA (1.2 V/R_{19}).

The input FET is DC-coupled to the measurement amplifier and thus determines the bias setting by means of its drain voltage of between 4 V and 5 V. The inverting input of the 'discrete opamp', T_2–T_6, is formed by the base of T_3. This is DC-coupled to the output of the measurement amplifier by feedback resistor R_{15}, so that the differential amplifier regulates the direct voltage at the output (collectors of T_5-T_6) to the value that exists at the non-inverting opamp input, the base of T_2.

The overall gain for alternating voltages is either 83 times or 26 times as determined by switch S_2, which selects feedback resistors R_{15}-R_{16} or R_{15}-R_{17} in series with a parallel combination of capacitors, C_{17}-C_{18}. This simple switch arrangement results in two sets of measurement ranges.

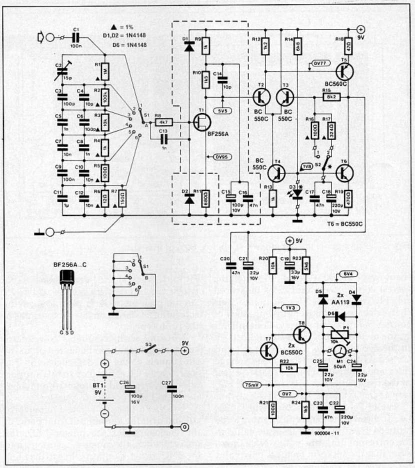


Fig. 1. Circuit diagram of the wideband millivoltmeter.

Fortunately, the transistors offer stable operation at relatively high frequencies, so that frequency compensation with a small ceramic capacitor is not needed in the AC feedback network. In practice, C_{14} alone does the job adequately.

Active rectifier

The signal rectifier is capacitively coupled to the measurement amplifier by C_{20} and C_{21}. The active part consists of a two-stage amplifier around T_7-T_8, which uses the rectifier and the moving-coil meter as part of its feedback network to achieve linear operation. The result is a high sensitivity of about 21 mV at the input of the rectifier for full-scale deflection (f.s.d.) of the moving-coil meter. The double meter scale is virtually linear, as shown on the front-panel layout in Fig. 3.

The high as well as stable amplification of the instrument results in a measure-

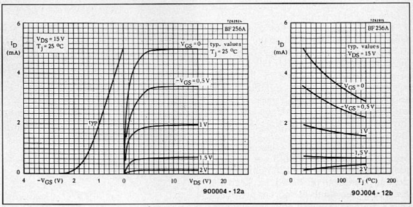


Fig. 2. BF256A FET design data.

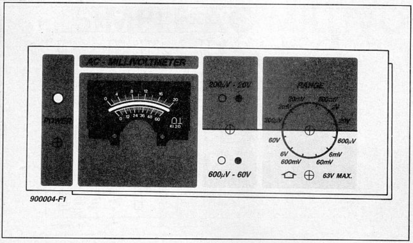


Fig. 3. Front-panel lay-out (shown at approx. 60% of true size).

ment range of 200 μV f.s.d., in which the lowest signal level that can be measured reliably is determined by the noise levels that exist in the discrete opamp and, of course, in the power supply. Consequently, the meter will not normally indicate '0' in the 200 μV range. Capacitors C_{26} and C_{27} reduce the noise on the supply voltage lines and compensate the negative effect of the rising internal resistance of the battery as this is slowly discharged.

Preset P_1 determines the form factor, i.e., it allows the meter indication to be reduced from the peak-to-peak value to the corresponding rms value. Note, however, that the set form factor is only valid for sine-wave voltages: the AC millivoltmeter does not contain a true-rms converter.

The signal rectifier consists of germanium diodes D_4-D_5. Silicon diode D_6 protects the coil in the meter against overloading.

Construction and alignment

As with the previous two instruments in this series, the construction depends entirely on the combination of the printed-circuit board (Fig. 4), the metal enclosure and the front-panel layout (Fig. 3). Together, these give a compact instrument that is simple to build because the wiring is kept to a minimum.

The two rotary switches are 6-way types with a special ring to set the number of positions. Set the ring to two positions on S_2. The same ring may be omitted or set to six positions in the case of the range selector, S_1. Select two suitable collet knobs for the switches and provide them with an additional pointer arrow opposite the one already printed on the plastic collar.

The population of the single-sided printed-circuit board should not present problems. Be sure to fit all components as close as possible to the board, i.e., keep all component terminals as short as possible. Check your work every now and then to prevent a long fault-finding session later.

Fit solder pins at the locations shown between the rotary switches. Next, bend a 20-mm high piece of tin plate to form the screening as shown on the photographs of the prototype board.

Cut and drill a suitable aluminium support plate that can be bolted on to the side panels of the LC-850 enclosure. The completed PCB is fitted on to this support plate with the aid of four 10-mm high threaded PCB spacers.

Use the front-panel foil as a template to cut and drill the aluminium front panel of the enclosure. Fit the power LED, the on/off switch, the moving-coil meter and the BNC socket. Connect wires to the LED, the switch and the meter, and a short length of screened cable to the BNC socket.

Remove the rear panel of the enclosure, and insert the support plate with the PCB on it vertically between the side brackets of the enclosure. Move the assembly towards the front of the enclosure until the PCB is at about 50 mm from the front panel. This position allows enough room for the body of the moving-coil meter. Mark the holes in the side brackets to be used for securing the support panel. Cut the rotary switch spindles at the required distance from the front panel. Check if the two collet knobs fit, and remove them again.

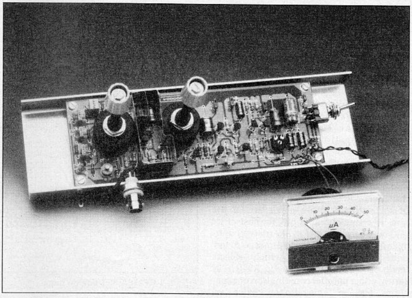
The enclosure has ample room behind the vertically fitted support plate for a 9-V battery or a battery pack made up of six penlight types. Rechargeable batteries may also be used, in which case it is necessary to fit a charge socket on the rear panel of the enclosure. The AC millivoltmeter must never be powered by a mains adapter without an internal 9 V regulator.

Setting up

The instrument is aligned before it is re-assembled and fitted into the enclosure. Connect the meter, the on/off switch, the LED, the BNC socket and a 9-V battery. Fit the knobs provisionally on the switch spindles.

Switch on, and check that the current consumption is 7–8 mA. Use a digital multimeter to measure the voltage at the anode of D_3 (+1.8 V) and the positive terminal of C_{21} (between +5 V and +6 V). The latter voltage must be virtually equal to that at the drain of T_1. If this is not the case, replace the FET, or adapt R_{11}. Check that the collector of T_8 is at about +6.4 V.

Set the instrument to the 60 V range and adjust the mechanical meter setting to an indication of 0. Connect a sine-wave generator to a digital multimeter set to alternating voltage measurement. Set the generator to a frequency between 100 Hz and 200 Hz. Connect a 1000:1 voltage divider between the input of the DMM and the input of the AC millivoltmeter. This voltage divider consists of a 10 kΩ- and a 10 Ω resistor (both at 1% tolerance). Set the millivoltmeter to the 0.6 V range and the DMM to the 1 V or 3 V range. Adjust preset P_1 for corresponding readings on the DMM and the AC millivolt-



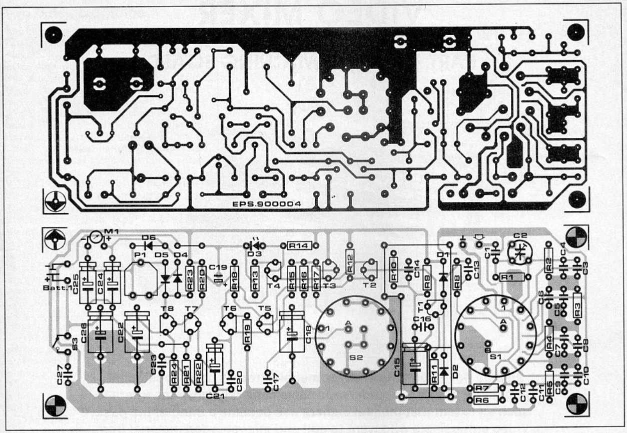


Fig. 4. Track layout and component mounting plan of the single-sided printed-circuit board for the millivoltmeter.

meter — i.e., disregard the multipliers 1 (V) and 0.001 (mV) — and check the adjustment for a couple of amplitude settings on the generator.

Check the indications on the millivoltmeter against those on the DMM. If the meter scale deviates considerably, try fitting another pair of diodes in positions D_4 and D_5 (Types BAT85 may be used if the stated germanium diodes are hard to obtain).

Since 1%-tolerance resistors are used in the input attenuator, the indications in the other ranges follow the results of the above alignment to within 1%.

Trimmer C_2 is adjusted for optimum compensation at an input frequency of 200 kHz. An oscilloscope and a sine-wave oscillator are required for this calibration to compare the indicated levels in the 200 mV ranges. If these instruments are not available, set C_2 to about two-thirds of its range to give a capacitance of 10–12 pF.

The prototype shown in the photographs has a 1-dB bandwidth of over 4 MHz, and an indication error smaller than 5% at 2 MHz.

Previously featured test equipment in this series:

RF inductance meter. *Elektor Electronics* October 1989.

LF/HF signal tracer. *Elektor Electronics* December 1989.

Parts list

Resistors:

R_1 = 1M0; 1%
R_2 = 100k; 1%
R_3 = 10k; 1%
R_4 = 1k0; 1%
R_5;R_{16} = 100Ω; 1%
R_6 = 12Ω; 1%
R_7 = 150Ω; 1%
R_8 = 4k7
R_9;R_{13} = 1k0
R_{10};R_{24} = 1k5
R_{11} = 680Ω
R_{12} = 1k2
R_{14} = 6k8
R_{15} = 8k2
R_{17} = 342Ω; 1%
R_{18} = 47Ω
R_{19} = 470Ω
R_{20};R_{22} = 10k
R_{21} = 100Ω
R_{23} = 5k6
P_1 = 10k preset H

Capacitors:

C_1;C_{27} = 100n ceramic
C_2 = 15p trimmer
C_3 = 100p polystyrene (styroflex)
C_4;C_{14} = 10p
C_5 = 1n0
C_7 = 10n
C_6 = 100p
C_8;C_{13} = 1n0 ceramic
C_9 = 100n
C_{10};C_{12} = 10n ceramic
C_{11} = 1µ0
C_{15} = 100µ; 10 V
C_{16};C_{17};C_{20};C_{23} = 47n ceramic
C_{18};C_{22} = 220µ; 10 V
C_{19} = 33µ; 16 V tantalum bead
C_{21};C_{24};C_{25} = 22µ; 10 V
C_{26} = 100µ; 16 V

Semiconductors:

D_1;D_2;D_6 = 1N4148
D_3 = amber or high-intensity LED
(U_f = 1.8 V; see text)
D_4;D_5 = AA119
T_1 = BF256A
T_2;T_3;T_4;T_6;T_7;T_8 = BC550C
T_5 = BC560C

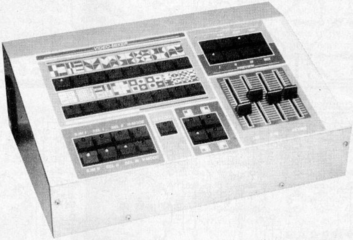
Miscellaneous:

S_1;S_2 = 2-pole 6-way rotary switch for PCB mounting.
S_3 = miniature SPDT switch.
BT_1 = 9-V battery with clip.
M_1 = 50 µA moving-coil meter e.g., Monacor Type PM2.
Metal enclosure: H=80 mm; W=200 mm; D=180 mm. E.g., Telet LC-850 (C-I Electronics, P.O. Box 22089, 6360 AB Nuth, Holland).

VIDEO MIXER

PART 1: VIDEO SWITCHING BOARD

A. Rigby



Recent developments in consumer electronics have boosted the popularity of video recorders, portable cameras and camcorders to such an extent that the film camera has become a thing of the past. Video enthusiasts who want to edit and mix recorded material from various video sources, and in addition require special fade-in and fade-out effects, will delight in building and using the advanced mixing desk presented here.

Not so long ago, a small fortune would buy a bulky video recorder offering mono sound, a primitive programming facility and just acceptable picture quality if the tracking control was re-adjusted from time to time. Today's camcorders (camera-recorders) cost less than these old VCRs, but offer significantly improved sound and picture quality. Stereo sound, Super-VHS and all-digital recording techniques are already available but will take some time to become established in the consumer markets.

In spite of all its technological benefits, the camcorder has one disadvantage when compared to, say, an 8-mm film camera: editing recordings requires a mixer, of which there appear to be few around that can be purchased ready-made at a reasonable price.

The video mixer/effects unit described here allows a up to three video signals to be combined into one video output signal. The mixer also offers a number of special effects which result in attractive fade-in, fade-out and superimpose effects.

An important proviso must be mentioned at the outset: depending on the number of video sources connected to the mixer, at least one (two sources) or two (three sources) must have an external synchronization input. One video source always serves as the master sync source, the other (one or two) are externally synchronized.

The mixer always mixes two signals, even when three signals are applied. It does not allow three signals to be shown simultaneously. The mixing options are:

- video 1 with video 2
- video 1 with video 3
- video 2 with video 3

Again remember that video sources that lack an external synchronization input can not be mixed. The reason for this is probably familiar to those who have experience working with video signals, but may be less obvious to many other readers. Mixing video signals is essentially alternate switching between lines of two TV pictures. To maintain phase synchronism between the two pictures, their picture line content must start at the same instant. The synchronization pulses in the video signal serve to time this instant. The sync pulse frequencies of the two video sources will not be equal if the syncs are derived from free-running clock circuits as used in most portable cameras. Hence, a single synchronization source is required to prevent the two pictures 'floating' with respect to one another in the mixed image.

It would not be fair to say that the video mixer is a simple-to-build project. The final design is relatively complex, and construction is only recommended to readers who have experience in working with video signals, and who are confident of their soldering skills.

Lozenge-insertion: one of the many picture mixing effects.

Two block diagrams

The basic operation of the video mixer is best understood by looking at the block diagram in Fig. 1. The three blocks shown in the drawing represent the three circuits that make up the video mixer. Each circuit is constructed on a separate printed-circuit board. This first instalment of a four-part article deals with the video switching board. Part 2 discusses the modulation board, and Part 3 the keyboard. Part 4, finally, addresses matters related to the adjustment and practical use of the video mixer.

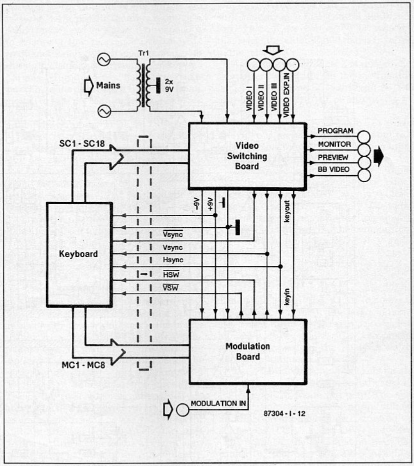


Fig. 1. Block diagram of the video mixer. The circuit is accomodated on three printed-circuit boards.

The block diagram shows four inputs, VIDEO I, VIDEO II, VIDEO III and VIDEO EXP. The first three accept the video signals that are to be mixed. Input VIDEO I takes the master signal that ensures the central synchronization. The video source connected to this input does not require an external synchronization input, and must always be present to provide the master sync signals for the other video source(s). The other two inputs, VIDEO II and VIDEO III, are identical, and take signals from sources synchronized with VIDEO I.

The fourth mixer input, VIDEO EXP (expansion input), takes an additional signal that may be routed to the monitor when none of the other inputs is being used. This 'stand-by' signal may be supplied by a test chart generator or logomat. It can not be mixed with the other channels.

The video mixer has four outputs. The BLACK-BURST (BB-video) output supplies the composite synchronization signal for the video sources. Outputs PROGRAM and MONITOR are electrically identical and supply the mixed video output signal. The PREVIEW output, finally, allows the video-1, video-2, video-3, or the mixed video signal to be viewed independently of the other outputs.

The video switching board divides the synchronization signal recovered from video-1 between the sub-circuits. The control signals for the modulation and the switching board emanate from the keyboard circuit (to be discussed in Part 3). The function of these control signals, marked SCxx, will be reverted to in due course.

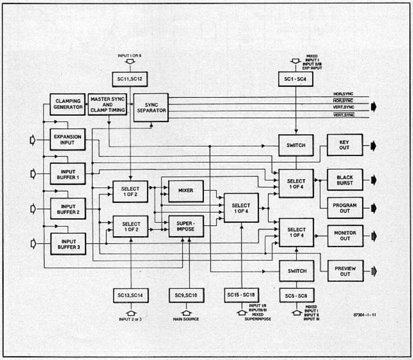


Fig. 2 Block diagram of the first module, the video switching board.

Figure 2 shows the block diagram of the video switching board. The input buffers are at the left, the outputs at the right. Electronic switches at a number of locations select the required signals. The control blocks at the top of the diagram are used to generate the sync signals and enable the colour burst in the master signal to be inserted at the right instant into the output signal. In the mixer circuit, the horizontal and vertical sync signals are available separately in true as well as inverted form. The KEYOUT output allows a kind of picture-in-picture effect to be achieved: one particular colour is removed from the picture on one channel, to be filled in by corresponding areas in the picture on the other channel. This effect is often used in TV news broadcasts to create a background for (apparently large)

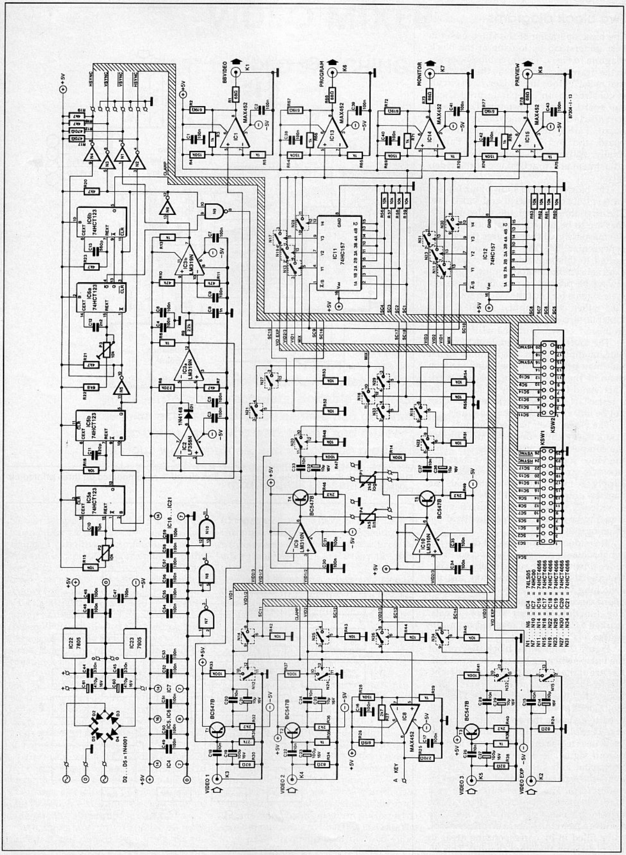


Fig. 3. Circuit diagram of the video switching module in the mixer.

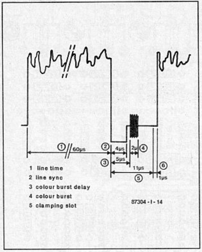


Fig. 4. Picture line timing.

weather maps.

Switching unit: the practical circuit

Although the circuit is fairly complex, the diagram in Fig. 3 gives a good insight into the operation of the video switching board.

The video signal applied to the VIDEO I input, socket K$_3$, serves to synchronize all other sources. Opamps IC$_2$, IC$_{3a}$ and IC$_{3b}$ form a synchronization separator. Circuit IC$_2$ clamps the input signal, while IC$_{3a}$ and the associated filter recover the line sync pulses. These trigger IC$_{5a}$, a monostable multivibrator (MMV), whose output pulses have a fixed length of 60 µs. These pulses keep a second MMV, IC$_{5b}$, from being started by interference during the picture line time, and ensure that a 4 µs horizontal sync pulse is generated by IC$_{5b}$ at the end of the line only. This gives a total time of 64 µs for the line content and the sync pulse, as shown in Fig. 4. The first picture information appears in the line 12 µs after the start of the line sync pulse. The third MMV, IC$_{6a}$, ensures that the line sync pulse and the colour burst recovered from video 1 are applied to all other video signals. This is achieved by NAND gate N$_9$ switching multiplexers IC$_{11}$ and IC$_{12}$ in a way that video-1 signals present during an 11 µs interval around the line sync pulse are passed to the output (by pre-selection on the $\overline{A}$/B input).

Circuit IC$_{6b}$ generates a clamp pulse of approximately 1 µs before the start of the picture line content. The clamp pulse serves to define the absolute black level as a direct-voltage reference in the video signal.

The analogue circuitry on the video switching board starts at the left of the circuit diagram with three input buffers around transistors T$_1$, T$_2$ and T$_3$. These ensure that the video sources are terminated into the correct impedance, and further ensure sufficient drive for use at various points in the circuit. The inputs asa well as the outputs of the buffers are in series with parallel combinations of a solid (MKM) and an electrolytic capacitor to ensure a low reactance over a wide frequency range, which ensures that both the vertical and the horizontal sync pulses are passed undistorted. Each buffer output can be short-circuited by an electronic switch to give the required reference black level. The electronic switches are controlled by the clamping pulse.

There is a fair number of electronic switches between the buffers and the output. These switches are controlled from the keyboard circuit and select the two video signals that are to be mixed. The selected signals are first buffered for the benefit of two mixing effects.

First, the opamps used allow the signals to be mixed by potentiometer P$_4$. The mixed video signal at the wiper is passed through a series of electronic switches before it arrives at the output buffers, IC$_{13}$, IC$_{14}$ and IC$_{15}$.

Second, the amplifier that follows the mixer stage is used for the superimpose effect. Although the circuit around potentiometer P$_1$ looks similar to the mixer stage, it works altogether differently. Transistors T$_4$ and T$_5$ ensure sufficient buffering between the mixer and the superimpose stage, while potentiometer P$_1$ forms an adjustable short-circuit between the two video signals, which are mixed in a way that ensures that their brightest picture areas are passed to the output. Effectively, a relatively dark area in one picture is covered by a brighter one at the same location in the other picture. Switches N$_{20}$ and N$_{22}$ determine the video channel selection if the superimpose function is not used (P$_1$ set to maximum).

Circuits IC$_{11}$ and IC$_{12}$ have a number of functions related to the control of the video switching board. These functions will be reverted to in Part 2. For now, it is sufficient to say that control lines SC1 through SC8 are connected to switches that select the video signal that is to be fed to the output.

As will be seen in Part 2 of this article, the pattern generator on the modulation board controls lines SC15 through SC18 to enable two pictures to be mixed via an intermediate effect.

The circuit around opamp IC$_8$ raises the video signal at the VIDEO II input to a level suitable for driving the keying input on the modulation board.

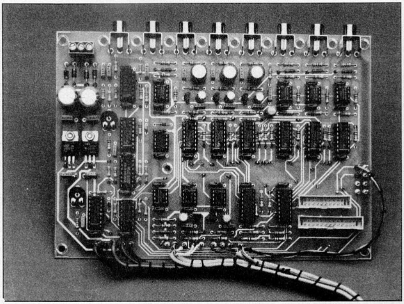
The power supply is quite simple. Every board has its own regulator, which takes the unregulated supply voltage from the central power supply. The video switching board has two local regulators, IC$_{22}$ and IC$_{23}$ to provide the symmetrical, regulated supply voltages of +5 V and –5 V.

Construction

The printed-circuit board for this part of the project is a relatively large, double-sided and through-plated type, which is available ready-made. The component overlay shows that the board is fairly densely populated.

Use PCB-mount phono sockets for the video inputs and outputs as indicated on the component mounting plan. The synchronization signals, the supply voltage and the potentiometers are connected via solder pins. PCB headers KSW$_1$ and KSW$_2$ mate with IDC sockets fitted on short flat-cables that connect the video switching board to the keyboard unit and the modulator board.

Start the construction with fitting all connectors, solder pins and phono sockets. Then follow the passive components. Ample decoupling is provided by inex-



Completed prototype of the video switching board.

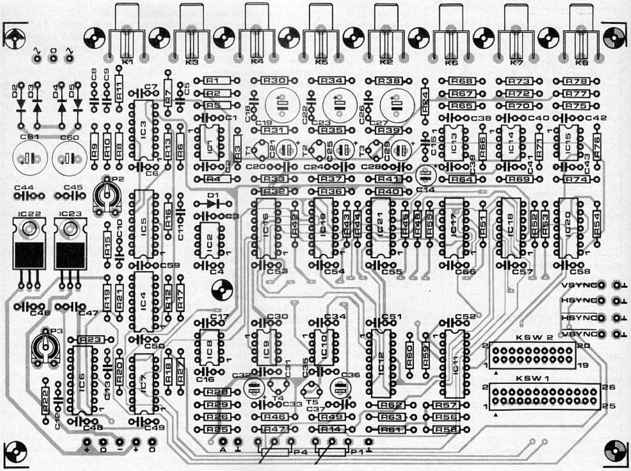


Fig. 5. Component mounting plan of the video switching board. The input and output cables are connected to PCB-mount phono sockets.

Parts list

Resistors:

$R_1;R_{68};R_{73};R_{78} = 68\Omega$

$R_2;R_{26};R_{67};R_{72};R_{77} = 619\Omega$ (E96)

$R_3;R_5;R_8;R_{13};R_{29};R_{35};R_{39};R_{65};R_{66};R_{70};R_{71};R_{75};R_{76}$ = 1k0

$R4;R_{28};R_{64};R_{69};R_{74}$ = 150k

R_6 = 220k

$R_7;R_{18} - R_{21};R_{23}$ = 4k7

R9 = 22k

$R_{10};R_{11}$ = 47k

$R_{12};R_{17} = 470\Omega$

$R_{32};R_{36};R_{40};R_{46};R_{49}$ = 2k2

R_{31} = 27k

$R_{15};R_{16};R_{42} - R_{45};R_{48};R_{51} - R_{63}$ = 10k

R_{22} = 6k8

$R_{24};R_{30};R_{34};R_{38} = 82\Omega$

R_{27} = 2k7

$R_{14};R_{33};R_{37};R_{41};R_{47}$ = 100k

$R_{25} = 270\Omega$

P_1 = 2k5 logarithmic potentiometer

$P_2;P_3$ = 10k preset H

P_4 = 2k5 linear potentiometer

Capacitors:

$C_1 - C_7;C_9;C_{16};C_{17};C_{30};C_{31};C_{34};C_{35};C_{38} - C_{43};C_{46} - C_{59}$ = 100n

C_8 = 1n0

$C_{60};C_{61}$ = 470µ; 16 V; radial

C_{11} = 820p

C_{12} = 2n2

C_{13} = 560p

$C_{10};C_{15};C_{18};C_{20};C_{22};C_{24};C_{26};C_{28};C_{33};C_{37}$ = 10n

$C_{19};C_{23};C_{27}$ = 100µ; 16 V; radial

$C_{14};C_{21};C_{25};C_{29};C_{32};C_{36}$ = 10µ; 16 V; radial

$C_{44};C_{45}$ = 330n

Semiconductors:

D_1 = 1N4148

$D_2 - D_5$ = 1N4001

$IC_1;IC_8;IC_{13};IC_{14};IC_{15}$ = MAX452

IC_2 = LF356N

IC_3 = LM319N

IC_4 = 74LS05

$IC_5;IC_6$ = 74HCT123

$IC_9;IC_{10}$ = LM310N

$IC_{11};IC_{12}$ = 74HCT157

$IC_{16} - IC_{21}$ = 74HCT4066

IC_{22} = 7805

IC_{23} = 7905

$T_1 - T_5$ = BC547B

Miscellaneous:

$K_1 - K_8$ = PCB-mount phono socket.

KSW_1 = 26-way pin header.

KSW_2 = 20-way pin header.

PCB Type 87304-1

pensive miniature 100 nF ceramic capacitors. IC sockets may be used, but are not strictly required. Note that many electrolytic capacitors are radial (PCB-mount) types to save board space.

Bend the terminals of the voltage regulators at right angles and secure these devices with a short M3 bolt. The regulators remain cool under normal conditions, and do not require heat-sinks.

Finally, check your work so far. Inspect the completed PCB for incorrectly fitted parts and short-circuits. The adjustment of P_2 and P_3 will be discussed in Part 4 of this article.

To be continued next month

THE DIGITAL MODEL TRAIN

PART 10 – RS232 INTERFACE

by T. Wigmore

The 9-way D-connector at the edge of the mother board offers the possibility of controlling the model railway by computer. This opens the way for fully automatic control of locomotives, turnouts (points), signals, protection of selected sections of the track, service schedules, simulated inertia of trains, combining locomotives for heavy goods trains, the switching of additional functions in rolling stock, and more.

The RS232 interface is compatible with the Märklin interface as far as standard instructions are concerned: the control of turnouts (points), signals and locomotives, and the calling for monitoring information. However, it offers many other facilities as well, such as requesting the state of locomotive controllers; the allocation of addresses to locomotive controllers; the disablement of keyboards and locomotive controllers as desired; the possibility of down-loading users' programs, and others. If manual control is not required, all keyboards and locomotive controllers may be omitted: all control instructions are then given via the interface. Mixed operation is also possible.

Originally, the RS232 standard was intended to couple a Data Communication Equipment (DCE, also called modem) and a Data Terminal Equipment (DTE), such as a computer. The standard is, unfortunately, abused by many manufacturers.

The Elektor Electronics Digital Train System is, strictly speaking, a DCE and, like the Märklin system, it uses three signal paths:

TxD: transmitted data – for data transport from the host computer to the EEDTS;
RxD: received data – for data transport from the EEDTS to the host computer;
CTS: clear to send – for advising the host computer that the EEDTS is ready for the next instruction.

Apart from these, an earth line is also required, so that the actual connexion cable must have at least four cores. A screen is not necessary. Recommended is four- or five-core flexible telephone cable. The length of the cable is of no consequence.

The cables shown in Fig. 62 will connect the EEDTS to most current computers that have an RS232 input. Some computers, such as the Commodore, require the signals to be inverted and their levels to be adapted to the TTL level; a suitable cable for these is shown in Fig. 63.

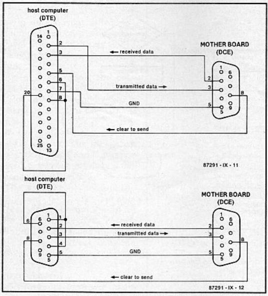


Fig. 62. Connexions of a standard RS232 cable using either a 25-way or a 9-way D connector at the DTE (computer) end.

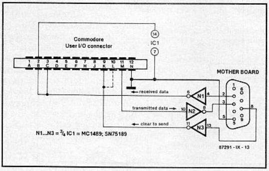


Fig. 63. When the EEDTS is to be connected to a Commodore, the signals must be inverted.

The gates used here may be those as yet unused in IC9 on the mother board.

Baud rate and data format

On power-up, the interface is set for 2400 baud, eight data bits, no parity bit and two stop bits. Instructions must not be followed by a carriage return. The baud rate may be altered if needed: for instance, in noisy (electronically speaking) conditions or where a very long RS232 cable is used, 1200 baud (instruction <111>) is a more congenial operating frequency. For extensive tracks, a baud rate of 4800 (instruction <113>) is recommended. A reset, either by S3 or instruction <98> returns the operating frequency to 2400 baud.

The processing of an instruction received by the EEDTS is illustrated in Fig. 64. Basically, there are three types of instruction: 1-byte, 2-byte, and those that require the EEDTS to answer by data.

When a 1-byte or 2-byte command is received, CTS is deactuated for the short time the EEDTS requires to process the instruction. As soon as the stop bit is received, CTS becomes active again.

When an instruction is received that requires a response from the EEDTS, CTS is deactuated, and becomes active again only after the EEDTS has sent one or more data bytes to the DTE to indicate that the next instruction may be transmitted. This is half-duplex operation: full duplex working, that is, the simultaneous sending and receiving of data, is not possible.

The response time of the EEDTS depends on the type of instruction and, in the case of calling for monitoring information, on the numer of monitors used. The delay lies between 2 ms (one monitor) and 80 ms (62 monitors). This will be reverted

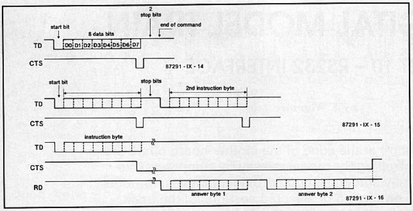


Fig. 64. The protocol for a 1-byte instruction (a); a 2-byte instruction (b); and a command that is followed by two answer-bytes (c).

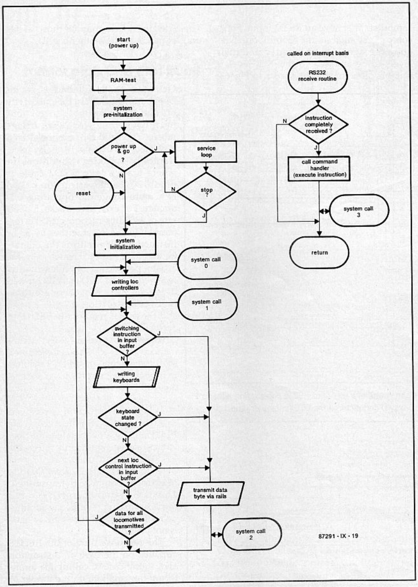


Fig. 65. Simplified flow diagram of the main loop in the system control program with indications where optional system programs may be called ((addressed).

to later.

EEDTS vs Märklin

All commands defined by Märklin have the same result in the EEDTS. Yet, there are several differences.

- In the stop mode, the Märklin system can receive only one instruction, whereas the EEDTS RS232 interface remains normally active. Monitor data can thus still be written. Switching instructions for turnouts (points) and signals may still be given but, since there is no voltage on the rails, they are retained in a buffer (up to 128 commands). When the buffer is full, CTS becomes inactive. As soon as the 'go' command is given, all switching instructions are executed in proper order.

- An energizing instruction for turnouts (points) or signals (<33>/<34>) must be followed in the Märklin system by a reset instruction (<32>). This is necessary to prevent the burning out of solenoids. In EEDTS, the reset instruction is generated automatically after a preset 'time out'.

- The numbering of turnouts (points) is slightly different between the two systems (see Table 7 in Part 9).Those that may be controlled via the RS232 interface are numbered 0–255.

- The monitor decoders in the Märklin system have 16 inputs, whereas those in the EEDTS have only eight. When the state of one monitor is requested, a program intended for the Märklin system expects a 2-byte reply. In the EEDTS a single byte would suffice, but there is then the likelihood that the program will wait (in vain) for the second byte. Therefore, the EEDTS provides Märklin simulation, in which it transmits the data of two units, i.e., two bytes, even if that of only one is called for. In other words, the monitor units are numbered in sets of two. If required, instruction <107> resets the system to the 'byte reply mode', in which the monitors are treated as single units again. After a reset or command <106>, the system is again in the 'word reply mode'.

System-status word and reset

The system status word, available with command <110>, contains information on the most relevant system data. After a reset or power-up, the system status word is 00H, which means that:

- the loc controllers and keyboards will be active as soon as the 'go' signal is given;
- there are no active switching instructions (system is in stop mode);
- the switching-instruction buffer is empty;

Instruction set

The instruction set is given in Table 8; all Märklin supported instructions are marked with an asterisk. All commands smaller than <80>, except <32>, are 2-byte instructions. The second byte of these consists of a loc address, a turnout (points) number and occasionally a time (the number indicated times 10 ms).

Instruction <32>, defined by Märklin as the turnout reset command, consists of only one byte and is active at the turnout number for which the latest switching command was given. This command is not used with the EEDTS.

Locomotive control

To actuate the additional function in Märklin loc decoders, the loc control instruction must be increased by 16. With EEDTS loc decoders the direction of travel is then reversed. The change-over instruction (<15> or, with actuated additional function, <31>) results in the EEDTS in the loc crawling backwards or forwards.

If a loc that is already controlled by a loc controller is also addressed via the RS232 interface, the controller is deactuated, since RS232 instructions have priority over others. Only after a loc enable instruction (<37>) or a system reset is the controller reactuated.

Turnout/signal control

Reset instruction <32> is not necessary. Command <33>, turnout straight on (signal green), means that the LED on the associated keyboard goes out. Instruction <34>, turnout turn-off (signal red) causes the LED to light.

When the status of one turnout is requested, the reply is one byte. This byte is false (0) if the turnout is set for straight on and true (255) if it is set for turn-off.

The standard turnout energizing delay after a reset or power-up is 250 ms. This delay may be altered to between 10 ms and 2.55 s by instruction <38>. The time is determined by the second byte (t = n × 10 ms).

The position of turnouts and signals may be requested in groups of eight (commands 160–190 for several groups and 224–255 for a single group). Each group of eight gets a 1-byte reply. Each bit in this represents a turnout or signal. For instance, on command <161> (requesting first two groups), bit 0 of the first reply byte represents the state of turn-out 0, bit 7 that of turnout 7, bit 0 of the second reply byte the state of turnout 8 and bit 7 of the second reply byte that of turnout 15. If the position of turnouts (points) is requested that have not yet been energized, the reply by definition is 0 (straight on). Only after turnouts and signals have been energized at least once can their actual position be ascertained.

Programming loc controllers

Each locomotive controller may be given an address with instructions <48>–<63>, but only if the eight DIL switches at the relevant loc controller are off.

An address allocated to a loc controller via the RS232 interface will be erased if another address is set with the DIL switches.

Requesting loc controllers

The reply consists of a loc data byte and a loc address byte – see Fig. 66. The returned loc data contain information on speed, direction, whether an additional function is active or not, and the type of data format. Bit 4 is 1 if the function is active (Märklin data format) or if the loc is moving backwards (EEDTS data format).

If the controller is set for the Märklin data format, bit 5 will give information on the direction of travel (it is set if the controller is positioned for backward travel).

Bit 6 is set when the controller is set for EEDTS data format (loc data increased by 64). If a controller is not in use, the returned loc data is 255.

If the requested controller status is to be used for loc control information, bits 5 and 6 must be masked before the loc data is returned to the EEDTS.

The second reply byte is the loc address, 0–80. Bit 7 of this address gives information on its origin. For instance, if bit 7 is set (loc address increased by 128), the address was set via the RS232 interface.

System control

The differences between emergency stop <97>, reset <98> and stop all locs <99> are:

- the emergency stop removes the voltage from the rails and will thus immobilize the entire track; if fairly soon afterwards the 'go' command is given, all locs will continue at their previous speed;
- a reset is followed by a new system-initialization; again, the track will be at standstill; all settings made via the RS232 interface will be erased; in contrast to the situation after power-up, the actual turnout and signal states are retained.
- when all locs are halted, the voltage is not removed from the rails, although all moving locs are stopped; any locs that are

Locomotive control*		
0–14	[loc address]	loc control instruction; additional function not active
15	[loc address]	loc reverse instruction; additional function not active (only for Märklin decoders)
16–30	[loc address]	loc control instruction; additional function active for Märklin decoders; reverse travel with EEDTS decoders
31	[loc address]	switch-over instruction; additional function active (only with Märklin decoders]
Control of turnouts; calling for state of turnouts/monitors		
32		reset last turnout (points) (1-byte command)*
33	[no. of turnout]	set turnout for straight on*
34	[no. of turnout]	set turnout for turn-off*
35	[no. of turnout]	request status of single turnout; reply: 1 byte (0 or 255)
36	no. of contact)	request status of single monitor; reply: 1 byte (0 or 255)
37	[loc address]	loc enable command for one loc
38	[time]	set turnout delay (default = 250 ms)
39	[time]	set error time (default = 1 second)
40–47	[..]	unallocated 2-byte commands (not defined)
Programming of loc controller		
48–63	[address]	loc controller address instructions (no of controller = instruction – 46)
Future loc decoder switching instructions		
64–79	[address]	loc decoder switching instructions reserved by Märklin; four functions per decoder (not yet defined)
Loc controller request instructions		
80–95		request status of loc controllers (80 = controller 1) reply = 2 bytes [loc data][loc address]
System control instructions		
96		go*
97		stop (default at power-up)*
98		reset
99		stop all locs (no stop or reset)
100		enable keyboards (default)
101		disable keyboards
102		enable loc controllers (default)
103		disable loc controllers
104		write monitor status; normal mode (default)
105		write monitor status; differential mode
106		set monitor units to word-reply mode (Märklin emulation; default at power-up)
107		set monitor units to byte-reply mode
108		request number of monitor units
109		request number of locs in use
110		request system status (1-byte reply)
111		set baud rate to 1200
112		baud rate 2400 (default)
113		set baud rate to 4800
114–117		unallocated instructions
Down-load commands		
118		set down-load mode for files in binary format
119		set down-load mode for files in Intellec format
120–127		calls to user programs (error if no code is present at relevant RAM location)
Request instructions for status of a number of monitor units*		
128		do not reset monitors after writing
129–159		request state of a number of monitors (1–31)
Request instructions for state of several groups of 8 turnouts/signals		
160–191		request status of turnouts/signals in several groups of 8
Request instructions for status of a single monitor unit*		
192		reset monitor units after writing
193–223		request status of single monitor (no. = command – 192)
Request instruction for status of turnouts/signals, single group of 8		
224–255		request status of any group of 8 turnouts or signals

Definition of parameters:

[loc address] =0–80
[no. of turnout] =0–255
[no. of monitor] = 0–255
[time] = 0–255 × 10 ms (0–2.55 s)

Table 8. Definitions of RS232 instructions.

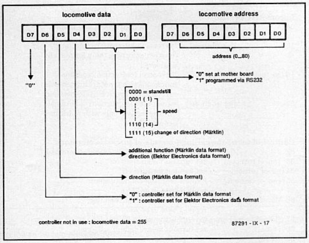

locomotive data
D7
D6
D5
D4
D3
D2
D1
D0
"0"
locomotive address
D7
D6
D5
D4
D3
D2
D1
D0
address (0...80)
"0" set at mother board
"1" programmed via RS232
0000 = standstill
0001 (1)
speed
1110 (14)
1111 (15) change of direction (Märklin)
additional function (Märklin data format)
direction (Elektor Electronics data format)
direction (Märklin data format)
"0" : controller set for Märklin data format
"1" : controller set for Elektor Electronics data format
controller not in use : locomotive data = 255
87291 - IX - 17

Fig. 67. Definition of the returned data when a loc controller is requested.

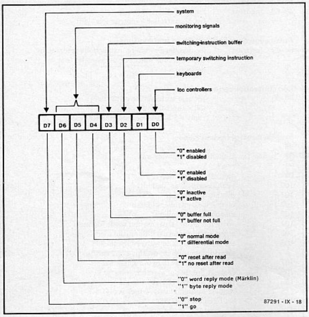


Fig. 68. Construction of system-status word: at power-up, it is 00H.

under the command of a controller will resume their previous speed; this may be prevented by preceding the stop all locs command by the loc controller disable instruction, <103>.

Disabling controllers and keyboards may be useful in fully automatic operation. When the keyboards are disabled, the yellow LED on the mother board lights.

Monitor signals

Instructions <106> and <107> enable the requesting of data from a single unit or from two units respectively. After power-up or a reset, the EEDTS is in the word-reply mode.

Monitor contacts are reset immediately they are written, unless the reset is disabled by <128>. The reset may be enabled again by <192>.

Normally, a monitor contact is written as a 1 if it is active. It is, however, possible with <105> to switch over to the differential mode, in which the contact is read as 1 only if it has altered. This makes it easy to see where something has happened.
The number of monitor units in use may be requested with instruction <108>.

Examples of programming

Since the program occupies some 200 Kbyte, it can not be given here. To help you on your way, however, some examples are given on how to actuate the basic functions of the EEDTS from GWBASIC (as supplied with every PC). If you use another variant of BASIC, or a different machine, or a different language, consult the associated handbooks.

The programming examples are fairly basic and they should therefore be treated as direction indicators only.

Before each command, the CTS line should be tested to see whether the system is ready to receive commands. This check is, however, often carried out by the system and also, for instance, by the GWBASIC interpreter. If instructions are attempted to be sent while the CTS line is inactive, the BASIC interpreter will give an I/O time out error. Generally, however, the processing of the commands is so rapid that no problems should be encountered.

INITIALIZING THE RS232 INPUT

```
10 REM closes all open files
20 CLOSE
30 REM open COM1(RS232)
    2400 Baud, no parity, 8 data
    bits
40 REM 2 stop bits as file 1
50 OPEN “COM1:2400,N,8,2”
    AS#1
```

LOCOMOTIVE CONTROL COMMAND

```
100 INPUT “give loc control com-
    mand (0–31)”COMMAND
110 INPUT “give loc address
    (≤80)” ADDRESS
120 PRINT #1,CHR$
    (COMMAND)
130 PRINT #1,CHR$
    (ADDRESS)
```

Note that the PRINT instructions in lines 120 and 130 must be closed by “;” to indicate that no carriage return must follow.

TURNOUTS CONTROL COMMAND

```
200 INPUT “give no. of turnout
    (0–255)” TURNOUTS
210 INPUT “position (0 =
    straight on; 1 = turn off”,
    POSITION
230 IF POSITION = 0 PRINT
    #1,CHR$(33); OTHERWISE
    PRINT#1,CHR$(34)
240 PRINT #1,CHR$
    (TURNOUT)
```

SETTING TURNOUTS DELAY (default = 0.25 s)

```
300 INPUT “new turnouts delay
    (0–255* 10 ms)” TIME
310 PRINT #1,CHR$(38)
320 PRINT #1,CHR$(TIME)
```

REQUESTING STATE OF MONITORS (193–223)

```
400 INPUT “required unit/group
    number (1–31)” UNITNR
410 PRINT #1,CHR$
    (UNITNR +192)
420 A$=INPUT$(2,#1)
430 PRINT “unit”
    (UNITNR–1)*2 +1 =
    “ASC(LEFT$(A$,1))
440 PRINT “unit”
    (UNITNR–1)*2 +2”
    “ASC(RIGHT$(A$,1))
```

In this example it is assumed that the system is in the word-reply mode; the monitor units are written as pairs. The digit ‘2’ in line 420 shows that a reply of 2 bytes is expected. These reply bytes are separated in lines 430 and 440. In the byte-reply mode, line 420 becomes:

```
420 A$=INPUT$(1,#1)
```

and line 440 is omitted.

REQUESTING STATUS OF A SINGLE MONITOR

```
500 INPUT “call monitor unit
    (0–255)” CONTACT
510 PRINT #1,CHR$(36)
520 PRINT #1,CHR$
    (CONTACT)
530 A$=INPUT$(1,#1)
540 CONTACT STATE=ASC(A$)
550 IF CONTACT STATE=0,
    B$=“not active” OTHERWISE
    B$=“(was) active”
560 PRINT “monitor”; CONTACT
    “is”; B$
```

REQUESTING STATUS OF TURNOUTS

The state of turnouts is requested in the same way as that of monitors with the exception that only a 1-byte reply follows a group of eight turnouts.

ALLOCATING A LOC ADDRESS TO A LOC CONTROLLER

```
600 INPUT “address setting in-
    struction for loc controller
    (1–16)”,REGNR
610 INPUT “required loc address
    (≤80)”,ADDRESS
620 PRINT
    #1,CHR$(REGNR + 47)
630 PRINT #1,CHR$(ADDRESS)
```

REQUESTING STATUS OF LOC CONTROLLER

```
700 INPUT “request instruction
    for loc controller (1–16)”,
    REGNR
710 PRINT
720 PRINT
    #1,CHR$(REGNR+79)
730 A$=INPUT$(2,#1)
740PRINT “locdata=”
    ASC(LEFT$(AS,1))
750 PRINT “loc address=”
    ASC(RIGHT$(A$,1))
```

In the last example, the reply also consists of two bytes (line 730) which are separated in lines 740 and 750 into the address for which the controller is set and the associated controller status (loc data).

RAM address	Call	Misc
4800H	system call 1	)
4900H	system call 2	) see Fig. 65
4A00H	system call 3	)
4B00H	system call 0	)
		instruction:
5000H	user call 0	<120>
5100H	user call 1	<121>
5200H	user call 2	<122>
5300H	user call 3	<123>
5400H	user call 4	<124>
5500H	user call 5	<125>
5600H	user call 6	<126>
5700H	user call 7	<127>

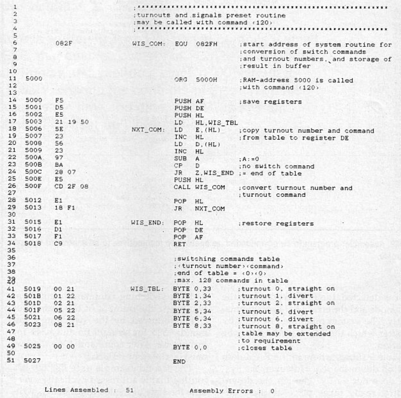
Table 9. RAM addresses available for down-loading.

- the monitor units are in normal mode and will be reset automatically after writing and the word reply mode is active;
- the stop-status is active (no voltage on the rails).

On a reset via S3 or instruction <98>, apart from the above default settings, the following will happen:

- all loc controllers are enabled, including those that are active at loc addresses where previously an RS232 command was active;
- the baud rate is set at 2400 baud;
- the energizing delay for turnouts (points) is set to 0.25 s;
- the loc addresses set via the RS232 at the loc controllers become inactive;
- all down-loaded user programs will be erased.

The situation after a reset is thus almost the same as after power-up; the only difference is that the prevailing positions of turnouts (points) and signals are retained.



```
 1                                 ;*************************************************************
 2                                 ;turnouts and signals preset routine
 3                                 ;may be called with command <120>
 4                                 ;*************************************************************
 5
 6        082F          WIS_COM:  EOU  082FH      ;start address of system routine for
 7                                                ;conversion of switch commands
 8                                                ;and turnout numbers, and storage of
 9                                                ;result in buffer
10
11  5000                          ORG  5000H      ;RAM-address 5000 is called
12                                                ;with command <120>
13
14  5000  F5                      PUSH AF         ;save registers
15  5001  D5                      PUSH DE
16  5002  E5                      PUSH HL
17  5003  21 19 50                LD   HL,WIS_TBL
18  5006  5E            NXT_COM:  LD   E,(HL)     ;copy turnout number and command
19  5007  23                      INC  HL         ;from table to register DE
20  5008  56                      LD   D,(HL)
21  5009  23                      INC  HL
22  500A  97                      SUB  A          ;A:=0
23  500B  BA                      CP   D          ;no switch command
24  500C  28 07                   JR   Z,WIS_END ;= end of table
25  500E  E5                      PUSH HL
26  500F  CD 2F 08                CALL WIS_COM    ;convert turnout number and
27                                                ;turnout command
28  5012  E1                      POP  HL
29  5013  18 F1                   JR   NXT_COM
30
31  5015  E1            WIS_END:  POP  HL         ;restore registers
32  5016  D1                      POP  DE
33  5017  F1                      POP  AF
34  5018  C9                      RET
35
36                                ;switching commands table
37                                ;<turnout number><command>
38                                ;end of table = <0><0>
39
40                                ;max. 128 commands in table
41  5019  00 21         WIS_TBL:  BYTE 0,33       ;turnout 0, straight on
42  501B  01 22                   BYTE 1,34       ;turnout 1, divert
43  501D  02 21                   BYTE 2,33       ;turnout 2, straight on
44  501F  05 22                   BYTE 5,34       ;turnout 5, divert
45  5021  06 22                   BYTE 6,34       ;turnout 6, divert
46  5023  08 21                   BYTE 8,33       ;turnout 8, straight on
47                                                ;table may be extended
48                                                ;to requirement
49  5025  00 00                   BYTE 0,0        ;closes table
50
51  5027                          END


        Lines Assembled :  51             Assembly Errors :  0
```

Fig. 68. Example of a programme in assembler to preset a number of turnouts (points) with instruction <120>. Underneath the associated down-load file in Intellec format.

Error LED

The error LED will light when the EEDTS receives an incompatible instruction. Examples of such commands, which are ignored by the system, are:

- a non-existent loc address;
- an attempt at addressing a loc controller that has already been set to a different address;
- calling for the status of a non-connected monitor;
- a non-defined instruction;
- addressing a non-down-loaded user program;
- the start bit on the serial channel is shorter than expected for the set baud rate (may also be a spurious pulse).

The diode will light for one second, unless this duration has been altered via command <39>, but in three situations it will light permanently:

- when during the auto test an error is detected in the RAM (when IC14 should be replaced);
- when a non-existent loc address has been set in the diode matrix (which thus should be undone);
- when a transmission error is detected during the down-loading of a file (possibly caused by a wrong baud rate – reset and try again).

Down-load mode

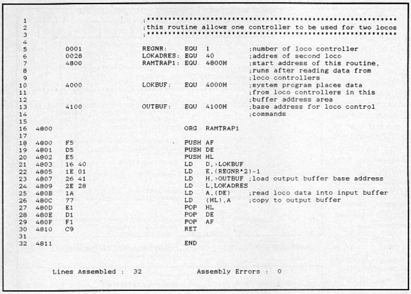
The down-load mode enables user programs to be loaded from the host computer into the RAM of the EEDTS in Z80 machine language.

Basically there are programs that are addressed by separate commands and programs that are addressed (called) cyclically by the EEDTS. Figure 65 shows where in the control program the EEDTS executes such a call to a possible user program.

Two instructions are available for down-loading: <118> and <119>.

Instruction <118> sets the binary down-load mode, in which the EEDTS expects a binary down-load file preceded by two 2-byte RAM addresses (high-order address part first). These addresses determine where the first and last byte will be written and must agree with the number of transmitted data bytes because each subsequent byte will be interpreted as a normal instruction.

Command <119> sets the EEDTS to a mode in which it is possible to down-load files in Intel"s Intellec-8 format. Most assemblers are able to create an output file in this format. Such a (strictly speaking ASCII) file contains apart from data also all necessary address information and a checksum for each block of 256 bytes. If through this checksum a transmission



```
                                   ;*************************************************************
                                   ;this routine allows one controller to be used for two locos
                                   ;*************************************************************

            0001                   REGNR:    EQU  1          ;number of loco controller
            0028                   LOKADRES: EQU  40         ;addres of second loco
            4800                   RAMTRAP1: EQU  4800H      ;start address of this routine,
                                                             ;runs after reading data from
                                                             ;loco controllers
            4000                   LOKBUF:   EQU  4000H      ;system program places data
                                                             ;from loco controllers in this
                                                             ;buffer address area
            4100                   OUTBUF:   EQU  4100H      ;base address for loco control
                                                             ;commands

    4800                                     ORG  RAMTRAP1

    4800    F5                               PUSH AF
    4801    D5                               PUSH DE
    4802    E5                               PUSH HL
    4803    16 40                            LD   D,>LOKBUF
    4805    1E 01                            LD   E,(REGNR*2)-1
    4807    26 41                            LD   H,>OUTBUF ;load output buffer base address
    4809    2E 28                            LD   L,LOKADRES
    480B    1A                               LD   A,(DE)     ;read loco data into input buffer
    480C    77                               LD   (HL),A     ;copy to output buffer
    480D    E1                               POP  HL
    480E    D1                               POP  DE
    480F    F1                               POP  AF
    4810    C9                               RET

    4811                                     END


        Lines Assembled :  32            Assembly Errors :  0
```

Fig. 69. Assembler program to be down-loaded to enable two locomotives to be controlled via one controller.

error is detected, the EEDTS goes into the stop mode and the error LED lights permanently. The system must then be reset by S3, after which the down-loading may be restarted.

Table 9 shows where in the RAM data may be down-loaded. However, the system does not verify whether the down-loading really takes place at these addresses: in principle, writing may take place anywhere in the RAM, even in those parts that are used by the system.

During down-loading, the main program is interrupted and the system is in the stop mode to prevent the addressing of a routine that is to be called cyclically before its down-loading has been completed. In the down-load mode, the yellow LED flashes in a 2 Hz rhythm

The down-loading is initiated by the command copy <file name> com1:. After the down-loading has been completed, the LED will stop flashing; the 'go' command must then be given to reactuate the system.

Some examples

Two examples will be given to illustrate what has been said so far.

The first is a routine (see Fig. 68) to set a number of turnouts (points) or signals (max. 128) to a given position.

Since this routine starts at address 5000H, it is actuated by command <120>. In the routine, the switching commands for the relevant turnouts and signals are first copied to register set DE and then, in system routine WIS COM, to the switching command buffer. The main program of the system will ensure that these switching commands are executed in due course. By adapting the data lines at the end of the routine, anyone is able to define his own presets for turnouts (points).

Each switching command consists of two bytes: the number of the turnout or signal followed by the switching command: <33> for straight on and <34> for turning off. After command <34> the row must be closed by 0000H.

The second example (see Fig. 69) is a routine that is addressed cyclically every time the state of the loc controllers is written. In this program, the data that was written by the loc controller is copied to the location for loc address 40 in the output buffer. This means that loc controller 1 will be active on the locomotive for which controller 1 has been set as well as on the locomotive with address 40. These locomotives are then coupled via software and may be controlled via one controller. This is, for instance, useful when a heavy goods train can not be pulled by one locomotive.

The coupled control is undone by sending a single byte (C9, the Z80 return command) to the start address in the RAM of the present routine. It may also be done by resetting the system.

In general, the original contents of all registers used in a user program should be stored in the stack from the beginning. At the end of the user routine, the contents of these registers must, of course, be recovered.

Listing on floppy

In the development of user programs a good knowledge of the EEDTS control program is indispensable. Unfortunately, this program can not be given in this article, since, together with the HEX codes, an extensive commentary, and cross-references, it occupies some 200 Kbyte. It is, however, available through the Readers' Services on a 5.25-inch, 360 Kbyte floppy under reference ESS-109.

ELECTRONICS NEWS

HIGH DEFINITION TELEVISION:

high stakes for the year 2000

One Sunday evening in the year 2010, somewhere between Tokyo, London and New York, someone switches on his high definition television set. He decides to watch a film. The flat screen, larger than the one on his old receiver, produces pictures as pure as those he is accustomed to seeing in his cinema. The stereo sound quality reminds him of his old compact disc player. The film is broadcast in the original language, although three other languages are available, since the stereo television is equipped with eight sound tracks.

The film is interrupted by a break for advertisements. Not in the least annoyed, our man simply instructs his television set to turn itself into a computer and display the first draft of the text of a lecture he is to give in Geneva the following week.

This is just one of the applications that high definition television may be offering in a few years' time. Other features are already in operation or under study:

- cinemas could receive HDTV film picture and sound from another town via satellite;
- thanks to the picture quality and enhanced colour production it offers, doctors specializing in, say, microsurgery will be able to use HDTV to teach their students;
- art galleries will be revolutionized: comfortably installed in an armchair, visitors will be able to view paintings by Matisse or Constable faithfully reproduced by HDTV cameras and stored in a video data bank;
- HDTV will be a boon to printing, publicity and other media sectors.

CMOS RAM CONTROL FOR PC-AT

from an idea by H. van den Bosch

The program listed here is written in Turbo Pascal to compile a small program, RTC-NVR.EXE, that enables owners of PC/ATs or any other IBM PC compatible fitted with a real-time clock (RTC) circuit to examine and, if necessary, change the contents of the non-volatile CMOS RAM that holds the time and date, as well as system configuration ('set-up') information.

Any PC-AT or compatible has a 64-byte CMOS RAM and a real-time clock powered by a re-chargeable battery. In the standard IBM PC-AT (who still has such an oldie?), the two functions are combined in a Motorola Type MC146818 integrated circuit on the motherboard. In the latest generation of AT compatibles, however, the RTC and the RAM are usually contained in one of the VLSI components that form part of the manufacturer's chip set. In general, owners of a PC-AT need not worry about the exact location of the RTC and non-volatile RAM: the only thing that counts is that the two can be found at the right memory address. Fortunately, most clone manufacturers keep to the I/O address assignment drawn up by IBM.

A timed surprise?

To be informed by the computer that the set-up information is lost owing to a system malfunction or an exhausted battery is at best a temporary nuisance and at worst the beginning of a real hassle to unearth notes made a long time ago on hard disk drive parameters, RAM bank configurations, wait states, and so on.

Although the required information can be refurnished relatively quickly with the aid of the set-up utility provided with the computer, it is useful in many cases to have the RTC/RAM contents available on paper in the form of a hex dump.

The author recently suffered a malfunction in the power supply of his PC-AT compatible. After this had been repaired, the machine on being switched on reported a hard disk controller fault, and could not be made to boot from drive C: as usual. The previously written utility RTC-NVR.EXE was available on floppy disk, however, and on being run indicated that the two checksum bytes at addresses 2E and 2F (see Tables 1 and 2) had been corrupted, probably as a result of the power supply malfunction. The bytes were recalculated, modified, and the machine performed a normal boot-up operation.

Document your settings

The listing in Fig. 1 is typed into Turbo Pascal and then compiled to obtain the required .EXE file. Routines 'upcase' and

```
program RTC_NVR;
{This program reads the contents of the Non-Volatile RAM on board the
 Real Time Clock chip of a PC/AT and allows the data to be changed.}

uses crt;

type str2 = string[2];

var  addr, data: byte;
     ch: char;

{*****************************************************************************}
function cb_hex (b: byte): str2;
{cb_hex converts byte b into a string with the hexadecimal representation
 of byte b}

const hexsigns: array [0..15] of char = '0123456789ABCDEF';

begin
  cb_hex := hexsigns [b shr 4] + hexsigns [b and $0F]
end; {function cb_hex}

{*****************************************************************************}
procedure read_RAM;
{read_RAM reads the contents of the non-volatile RAM}

var line, column: byte;

begin
  writeln ('hex address   hex data');
  writeln ('-----------   --------------------------------------');
  for line := 0 to 7 do
  begin
    write ('$',cb_hex(line * 8),'           '); {write address & 11 spaces}
    for column := 0 to 7 do
    begin
      port[$70] := line * 8 + column; {write address to RTC}
      write ('$',cb_hex(port[$71]),'  '); {read CMOS RAM and write contents}
    end;
    writeln
  end
end; {procedure read_RAM}

{*****************************************************************************}
begin {program}
  repeat
    clrscr; {clear screen}
    writeln ('RTC-RAM information');
    read_RAM;
    write ('change RAM (choose N to end)? [Y,N] ');
    ch := upcase (readkey); {read keyboard and convert input character
                             to upper case if necessary}
    write (ch);
    if ch = 'Y'
    then
    begin
      {**** WARNING **** CHECKSUM IS NOT RECALCULATED ****}
      writeln;

      write ('address in hex (e.g $3f) or decimal format? '); readln (addr);
      write ('                                      data? '); readln (data);
      port[$70] := addr;
      port[$71] := data;
      read_RAM;

      write ('press any key to continue...');
      repeat until keypressed; {wait}

      {clear keyboard buffer without using dummy variables}
      repeat if readkey='' then; until not keypressed

    end {if}
  until (ch <> 'Y') and (ch = 'N');
end.
```

900015 - 11

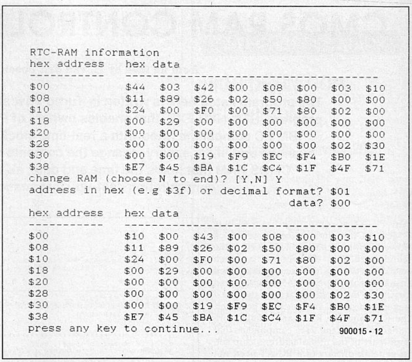
Fig. 1. Listing of the Turbo-Pascal program used to compile RTC-NVR.EXE.

Byte	Function	Address
0	Seconds	00
1	Second Alarm	01
2	Minutes	02
3	Minute alarm	03
4	Hours	04
5	Hour alarm	05
6	Day of week	06
7	Day of month	07
8	Month	08
9	Year	09
10	Status Register A	0A
11	Status Register B	0B
12	Status Register C	0C
13	Status Register D	0D

Table 2. Real-time clock addresses.

Addresses	Description
00–0D	Real-time clock information
OE	Diagnostic status byte
0F	Shut-down status byte
10	Diskette drive type byte (drives A and B)
11	Reserved
12	Fixed disk drive type (drives C and D)
13	Reserved
14	Equipment byte
15	Low base memory byte
16	High base memory byte
17	Low expansion memory byte
18	High expansion memory byte
19–2D	Reserved
2E–2F	2-byte CMOS checksum
30	Low expansion memory byte
31	High expansion memory byte
32	Date century byte
33	Information flags (set during power-on)
34–3F	Reserved

Table 1. CMOS RAM address map.



```
RTC-RAM information
hex address    hex data
-----------    ------------------------------------------
$00            $44  $03  $42  $00  $08  $00  $03  $10
$08            $11  $89  $26  $02  $50  $80  $00  $00
$10            $24  $00  $F0  $00  $71  $80  $02  $00
$18            $00  $29  $00  $00  $00  $00  $00  $00
$20            $00  $00  $00  $00  $00  $00  $00  $00
$28            $00  $00  $00  $00  $00  $00  $02  $30
$30            $00  $00  $19  $F9  $EC  $F4  $B0  $1E
$38            $E7  $45  $BA  $1C  $C4  $1F  $4F  $71
change RAM (choose N to end)? [Y,N] Y
address in hex (e.g $3f) or decimal format? $01
                                      data? $00
hex address    hex data
-----------    ------------------------------------------
$00            $10  $00  $43  $00  $08  $00  $03  $10
$08            $11  $89  $26  $02  $50  $80  $00  $00
$10            $24  $00  $F0  $00  $71  $80  $02  $00
$18            $00  $29  $00  $00  $00  $00  $00  $00
$20            $00  $00  $00  $00  $00  $00  $00  $00
$28            $00  $00  $00  $00  $00  $00  $02  $30
$30            $00  $00  $19  $F9  $EC  $F4  $B0  $1E
$38            $E7  $45  $BA  $1C  $C4  $1F  $4F  $71
press any key to continue...
```

Fig. 2. Print-out to illustrate the operation of the non-volatile RAM utility. The computer used for this test was a NEAT-286/4 AT compatible. By studying the dump carefully, you can see when this article was written, and how many seconds it took to modify the data at address $01, the seconds alarm in the RTC.

'readkey' are procedures resident in Turbo Pascal. Data is read via I/O port 71, while port 70 serves to address the 64 bytes. An example of the output of the program is shown in Fig. 2. The RAM addresses may be entered in hexadecimal (preceded by a $ sign) or in decimal.

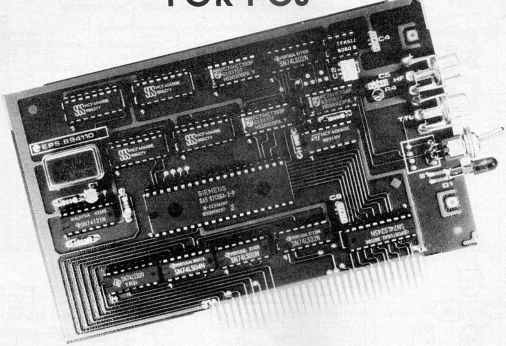
The program is also suitable for the popular Amstrad PC1640, and should also work on PC-XTs equipped with a multi-I/O card, although this has not been tested.

Finally, be sure to copy RTC-NVR.EXE to a floppy disk if you have compiled the program on hard disk. Make the floppy bootable by adding CONFIG.SYS, COMMAND.COM and an AUTOEXEC.BAT file that calls up RTC-NVR.EXE.

Byte(s)	Usage	Default
0–9	RTC time and date parameters	--
10	RTC control register A	070H
11	RTC control register B	002H
12	RTC control register C	--
13	RTC control register D	--
14–19	Time and date when machine was last used	--
20	User RAM checksum	--
21-22	Enter key translation token	01C0DH
23-24	Forward key translation token	02207H
25-26	Joystick fire button 1 translation token	0FFFFH
27-28	Joystick fire button 2 translation token	0FFFFH
29-30	Mouse button 1 translation token	0FFFFH
31-32	Mouse button 2 translation token	0FFFFH
33	Mouse X direction scaling factor	00AH
34	Mouse Y direction scaling factor	00AH
35	Initial video mode and drive count	020H
36	Initial video character attributes	007H
37	Size of RAM disk in 2-Kbyte blocks	000H

Table 3. Amstrad PC1640 non-volatile RAM address map.

1 GHz FREQUENCY METER CARD FOR PCs



H. Kolter

This plug-in card for IBM PC-XT/AT and compatibles forms a cost-efficient alternative to a stand-alone frequency meter. Simple to build and program, the card has a TTL input as well as a prescaler input with high sensitivity that can handle frequencies up to 1 GHz.

The signals on the expansion slots of an IBM PC or compatible machine form the starting point for the design of any extension card for this type of computer. The hardware that arranges the data flow and addressing must be laid out carefully to meet the technical requirements drawn up during the design stages. In practice, the eight bidirectional datalines between the extension card and the motherboard must be buffered to prevent the drive capacity of the CPU and associated peripheral chips being exceeded at the risk of permanent damage to the computer. The next requirement is that the extension circuit must occupy a carefully selected address range that can be accessed by the CPU in accordance with the I/O (input/output) map defined by IBM. Hence, the address range occupied by the extension card must be unique in the computer system to avoid I/O contention problems.

The frequency meter card presented here has a Type 8255 PPI (Programmable Peripheral Interface) to meet the above requirements as regards buffering and address decoding. All control of counter and clock circuits on the extension card is arranged by the CPU via the three data registers and one control register contained in the 8255 PPI.

Frequency measurement

Frequency measurement almost invariably requires a counter and a reference clock oscillator. Here, the latter function is realized by a 4 MHz oscillator block controlled by an on-board quartz crystal. This device comes in an encapsulated metal enclosure with pins that fit into an IC socket. The output signal of the oscillator block is applied to a divider circuit composed of individual, cascaded counter ICs. The output pulses of the last counter are applied to a NOR gate, the second input of which is driven by the measured signal. The output signal of the NOR gate clocks a counter cascade for the duration of the gate time. When the gate time is over, the counter state — which is proportional to the frequency of the measured signal — is taken over by one of the PPI ports, which transfers it to the CPU. A small BASIC program translates the counter state into the corresponding frequency, which is shown on the monitor. Before the next measurement cycle, all counters are cleared by a reset pulse of accurately defined length, generated with the aid of a programmed port line and a monostable multivibrator.

Ports and peripherals

The 8255 is probably the best known programmable I/O device designed for use with Intel microprocessors. It provides 24 I/O pins which may be individually programmed in two groups of 12, and used in one of three modes of operation. The content of the control register on board the 8255 determines whether the port lines function as an input or an output. In Mode 0, each group of 12 I/O pins may be programmed in sets of four to be input or output. In Mode 1, each group may be programmed to have 8 lines of input or output. Of the remaining four pins, three are used for handshaking and interrupt control signals. The third mode of operation, Mode 2, is a bidirectional bus mode that uses 8 lines for a bidirectional bus, and 5 lines for handshaking, borrowing one from the other group.

The 8255 on the frequency meter card, IC$_1$, operates in Mode 0 with all port lines

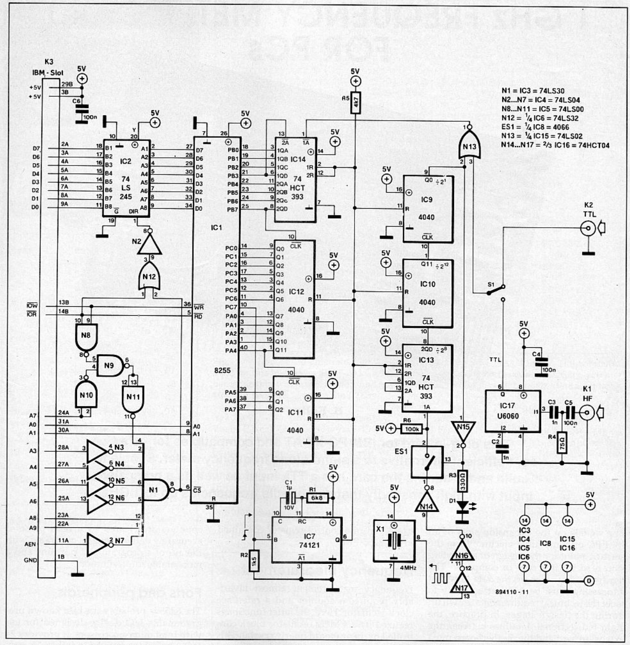


Fig. 1. Circuit diagram of the plug-in frequency meter card: the key components are the PPI, IC1, and the prescaler, IC17.

switched to inputs. Port C forms an exception, because one of its lines functions briefly as an output to supply the reset pulse for the counter cascade. The remaining pins of the 8255 are used to ensure correct interfacing with the CPU in the computer. PPI input pins $\overline{WR}$ (write) and $\overline{RD}$ (read) are driven direct by the PC expansion bus IOW (input/output write) and IOR (input/output read) signals that control the data direction. The 8255 is enabled by a low level at its $\overline{CS}$ (chip select) input. The $\overline{CS}$ signal is supplied by adress decoder N_1.

PPI inputs PORT SELECT 0 (A0) and PORT SELECT 1 (A1), together with inputs $\overline{RD}$ and $\overline{WR}$, control the selection of the ports and the control register in the 8255.

Circuit details

The input of counter cascade IC_{13}-IC_{10}-IC_9 is clocked by 4 MHz crystal oscillator block X_1. The counters are reset at power-on, so that output Q0 of IC_9 is low. This level is inverted by N_{15}, and electronic switch ES_1 is consequently closed. The clock pulses are counted by IC_{13}, a Type 74HCT393 set to a divisor of 2^8. Its output pulses clock IC_{10}, which is configured to divide by 2^{12}. Counter IC_9, finally, provides a divisor of 2^1, and supplies an output signal with a period of about 0.524 s at pin Q0. Pin 2 of gate N_{13} is held low until counter state $2^8 \times 2^{12} \times 2^1$ is reached. The measured signal taken from connector K_2 or the prescaler (IC_{17}) is applied to the second counter cascade, IC_{14}-IC_{12}-IC_{11}, via gate N_{13}. When the gate time (0.262 s) has lapsed, pin 2 of N_{13} goes high. This results in ES_1 being opened, so that the measured signal is no longer processed.

Next, the CPU reads the dataword (bit-combination) provided by ports A, B and C of the PPI at adresses 300H, 301H and 302H (768, 769 and 770 decimal). The counter state of IC_{11}, IC_{12} and IC_{14} is taken over as a 23-bit word for further processing. A series of BASIC commands (from line 910 onwards in the control program)

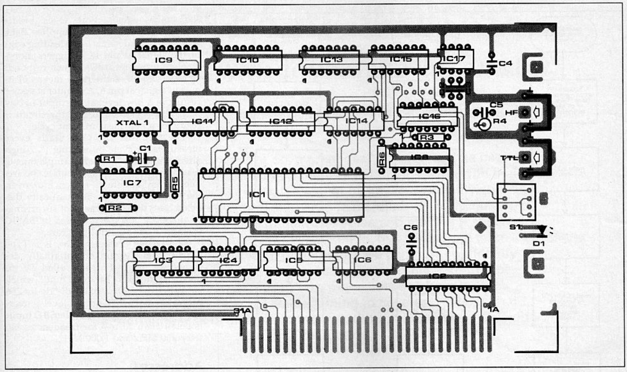


Fig. 2. Component overlay of the double-sided, through-plated printed circuit board. The PC slot contacts are gold-plated.

Parts list

Resistors:

R1 = 6k8
R2 = 1k5
R3 = 330Ω
R4 = 75Ω
R5 = 4k7
R6 = 100k

Capacitors:

C1 = 1µ0; 10 V; radial
C2;C3 = 1n0
C4;C5;C6 = 100n

Semiconductors:

D1 = LED (5 mm)
IC1 = 82555AC-2
IC2 = 74LS245
IC3 = 74LS30
IC4 = 74LS04
IC5 = 74LS00
IC6 = 74LS32
IC7 = 74121
IC8 = 4066
IC9;IC10;IC11;IC12 = 4040
IC13;IC14 = 74HCT393
IC15 = 74LS02
IC16 = 74HCT04
IC17 = U6060B (Telefunken)

Miscellaneous:

S1 = miniature SPDT switch for PCB mounting.
X1 = 4 MHz oscillator block.
K1;K2 = RCA (phono) socket for PCB mounting.
PCB Type 894110

```
10 CLS: BEEP: KEY OFF
20 GATETIME=.262144: FACTOR=1: B$="Hz"
30 GOSUB 460: REM start first measurement (also initialises PPI 8255)
40 PRINT"      ****************************************************************"
50 PRINT"      ***  PC FREQUENCY METER  ***      ***  ELEKTOR ELECTRONICS  **"
60 PRINT"      ****************************************************************"
70 LOCATE 23,1
80 PRINT"      H => Hz    K => kHz    M => MHz    R => RANGE    Q =>  QUIT"
90 REM TTL -------------------------------------------------------------------
100 LOCATE 5,8: PRINT"RANGE 1: 4 Hz - 32 MHz (+/- 4 Hz)                   "
110 LOCATE 7,8: PRINT"SWITCH TO LOWER INPUT SOCKET (TTL-input)"
120 PRESCALER=1
130 GOSUB 350: REM measurement
140 GOSUB 280: REM operation
150 IF A$="R" OR A$="r" THEN BEEP: GOTO 180
160 GOTO 130
170 REM HF ------------------------------------------------------------------
180 LOCATE 5,8: PRINT"RANGE 2: 30 MHz - 1 GHz (+/- 1 kHz) "
190 LOCATE 7,8: PRINT"SWITCH TO UPPER INPUT SOCKET (RF-input) "
200 PRESCALER=256
210 GOSUB 350: REM measurement
220 GOSUB 280: REM operation
230 IF A$="R" OR A$="r" THEN BEEP: GOTO 100
240 GOTO 210
250 REM leave program -------------------------------------------------------
260 CLS: KEY ON: END
270 REM operation subroutine ------------------------------------------------
280 A$=INKEY$
290 IF A$="Q" OR A$="q" THEN GOTO 260
300 IF A$="H" OR A$="h" THEN FACTOR=1:       B$="Hz"
310 IF A$="K" OR A$="k" THEN FACTOR=1000!:   B$="kHz"
320 IF A$="M" OR A$="m" THEN FACTOR=1000000!:B$="MHz"
330 RETURN
340 REM measurement subroutine ----------------------------------------------
350 WHILE TIMER<MITV: WEND: REM wait for measurement interval to lapse
360 A=INP(768)
370 B=INP(769)
380 C=INP(770)
390 GOSUB 460: REM start next measurement
400 C=C AND &H7F: REM mask bit 7 on port C
410 COUNT=32768!*A+256*C+B: REM use bytes read to calculate counter state
420 F=COUNT*PRESCALER/(GATETIME*FACTOR)
430 LOCATE 13,8: PRINT"FREQUENCY IN ";B$;" = ";INT(F+.5);"           "
440 RETURN
450 REM start next measurement   -------------------------------------------
460 OUT 771,147
470 OUT 770,128
480 OUT 770,0
490 OUT 771,155
500 MITV=TIMER+.5
510 RETURN: REM ------------------------------------------------------------
```

894110 - 15

Fig. 3. Listing of the GWBASIC program that controls the frequency meter card.

then takes effect. Port C is briefly switched to output and supplies dataword FFH (255 decimal). The leading edge of the signal at pin PC7 triggers monostable multivibrator IC7, which responds by resetting all counters by means of its output signal at pin 6. A counter state of 0 results in a low level at the input of N15. Also, ES1 is closed, so that the circuit is ready for a new measurement cycle.

The fact that the CPU starts every measurement cycle by making PC7 high already indicates that it has ample time to read the port contents, calculate the frequency, and update the screen. Moreover, the clock oscillator is automatically disabled after the gate time. Not surprisingly, therefore, the speed offered by BASIC is ample for the control program.

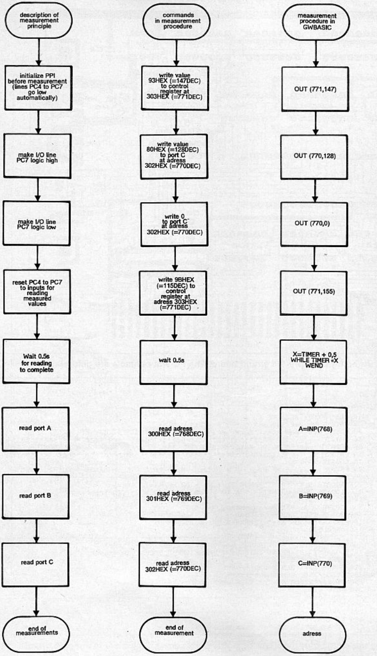
The 1 GHz prescaler, IC17, is a Type U6060 from Telefunken, originally designed for use in PLL-controlled TV tuners. The chip has a balanced input (which is not used here), a fixed divide-by-256 prescaler, and a TTL output level converter. The input sensitivity of the 50 Ω input is better than 20 mV for frequencies between 30 MHz and 1,000 MHz.

Addresses

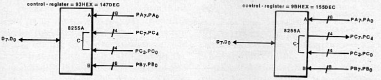
An address decoder set up around IC3, IC4 and IC5 monitors the logic levels on expansion bus address lines A3 through A9. The $\overline{CS}$ input of the 8255 is actuated only when A3 through A6 are low, and A8 and A9 are high, in combination with the AEN (address enable) line. When the 8255 is enabled, one of its four registers is selected by the bit combinations on A0 and A1. This means that the frequency meter card occupies the four I/O addresses, 300H through 303H, provided for prototyping cards in the PC. If any other extension card in the PC occupies the same addresses, it must be relocated by altering its jumper configuration as specified by the manufacturer. In general, extension cards can not share I/O address space without causing bus contention problems.

Software

The operation of the BASIC control program for the frequency meter may be analyzed in three ways as shown by the respective flow diagrams in Fig. 4. The BASIC program itself (Fig. 3) is straightforward, offering a kind of minimum user interface. The program is simply typed in under GWBASIC (available on any MS/DOS PC), saved to disk, and started with the RUN command. LED D1 flashes during measurements to indicate activity of the card. The program prompts you to select between the LF/TTL input and the HF input, and automatically switches between kHz and MHz readings on the screen.


description of measurement principle
initialize PPI before measurement (lines PC4 to PC7 go low automatically)
make I/O line PC7 logic high
make I/O line PC7 logic low
reset PC4 to PC7 to inputs for reading measured values
Wait 0.5s for reading to complete
read port A
read port B
read port C
end of measurements
commands in measurement procedure
write value 93HEX (=147DEC) to control register at 303HEX (=771DEC)
write value 80HEX (=128DEC) to port C at adress 302HEX (=770DEC)
write 0 to port C at adress 302HEX (=770DEC)
write 9BHEX (=115DEC) to control register at adress 303HEX (=771DEC)
wait 0.5s
read adress 300HEX (=768DEC)
read adress 301HEX (=769DEC)
read adress 302HEX (=770DEC)
end of measurement
measurement procedure in GWBASIC
OUT (771,147)
OUT (770,128)
OUT (770,0)
OUT (771,155)
X=TIMER + 0,5 WHILE TIMER <X WEND
A=INP(768)
B=INP(769)
C=INP(770)
adress

894110 - 16A



894110 - 16B

address		register
dec	hex	
768	300	port A
769	301	port B
770	302	port C
771	303	port D

Fig. 4. Flow-charts of the control program, and functional representation of the PPI in the address space it occupies in the PC.

SCIENCE & TECHNOLOGY

CONVERSING WITH COMPUTERS – NATURALLY

by Professor Marcel Tatham, Department of Language and Linguistics, University of Essex

For the past 20 years or so, a great deal of research has been aimed at enabling users of computers to communicate with their machines by voice only, instead of by keyboards and visual display units. What at first appeared to be relatively easy, getting a computer to talk with a human-like voice and making it able to respond appropriately when spoken to, has turned out to be extremely difficult. It is so difficult that we can now confidently predict that it will be several decades before fully natural, free-flowing conversation can take place between people and machines. Only now are we beginning to develop systems that perform the task in an acceptable way, though in certain restricted areas conversation with computers is already with us.

The scenario of a conversational system with a machine requires us to picture using a computer to replace one of a pair of human beings speaking to one another, that is, using the machine to simulate the behaviour involved in carrying out one side of the conversation. So we can begin by examining in general terms what it is that a person does during the communication process.

On the surface, what happens looks simple enough: when someone is spoken to, the immediate response is to speak back, enabling information to flow back and forth between the two speakers. We can model this behaviour as consisting of three separate components:

(1) hearing the message or question;
(2) thinking about how to respond;
(3) speaking the response.

Hearing is in fact a two-stage process. The speech signal enters the ear and almost immediately a complex acoustic analysis takes place in the inner ear. This is a passive process involving no thought on the part of the listener. The results of the analysis are sent to the brain where, in a second stage, cognitive processing takes place to further refine the analysis and to 'label' the data as particular speech sounds or words.

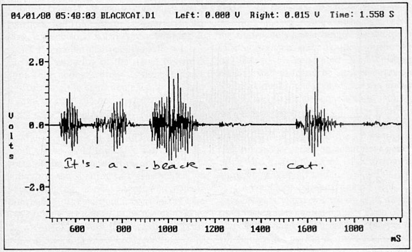


Fig. 1. Acoustic signal of the sentence "it's a black cat." It is easy to spot the individual words.

Before any response to the perceived signal can be generated, cognitive processes must take place that result in the listener's understanding of what has just been heard. Only when the message has been understood can the listener compose a suitable response.

Two stages are involved in speaking the response. First, the message needs to be encoded linguistically: thought is turned into language as preparations are made to adjust the speech organs to produce the appropriate acoustic signal. Second, a quite complex process of neuromuscular control is brought into play to make sure that lungs, vocal cords, tongue, lips and so forth are organized to produce the right sounds at the right time.

The processes are repeated over and over by each participant in the conversation as the exchange of information unrolls.

Simulating conversation

The basic idea of replacing one human being by a machine is simple enough: programs replace in turn the three stages of the human process being simulated. The first stage is parallel to the hearing process. A microphone picks up the speech signal and a program simulates the ear's analysis of the acoustic signal. The results of this analysis are processed by a second program which conducts the labelling task: the acoustic signal is identified as containing particular speech sounds that in combination represent individual words.

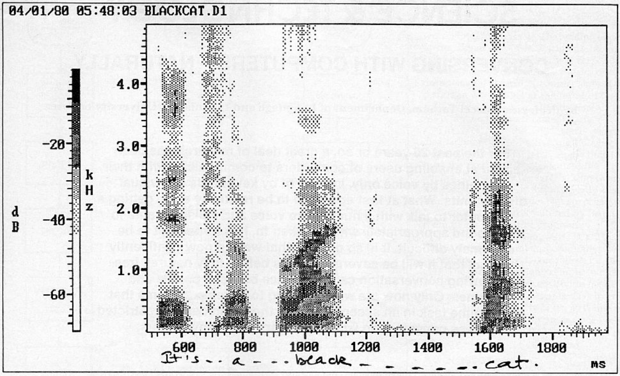


Fig. 2. Acoustic analysis by computers of the sentence in Fig. 1. In this, a kind of map of the inner details of the signal, the boundaries between the words are still easily detected.

The stage is usually called 'automatic speech recognition'.

The next stage in the simulation is to copy the human process of understanding the message content of the speech just received. We call this 'speech understanding', and it is by far the most difficult part of the system in which to achieve satisfactory results. People understand speech in the context of their accumulated experience of the world. Obviously, to put such knowledge into a computer is a vast, if not impossible, task. In practice ways are found of getting around the problem, usually by restricting the area of conversation as much as possible, so that the contexts the computer must know to interpret the information are narrowed down to a manageable size. The processes involved are studied within the field of artificial intelligence, which here means simulating the cognitive behaviour of people.

Once the computer has understood what has been said to it, it is able to formulate a response which must then be spoken. Speech synthesis forms the final stage of the process. A program takes the linguistically encoded response and, mimicking the way a human being produces an acoustic signal, produces speech through a loudspeaker.

Experience and labelling

The most difficult part of getting computers to hold conversations with people is the simulation of the cognitive processing involved in understanding what the person has said and in formulating an appropriate response. The reason for this is that speech signals do not contain within themselves all the information needed for their understanding. Take the simple sentence "it's warm today." Spoken during the winter this might mean that the temperature has risen to 10 degrees, but spoken at the height of summer it might well mean that the temperature has reached 25 degrees. Human beings talking to one another know whether it is winter or summer; the computer does not. All of us have spent our lifetimes acquiring such information which we use every time we interpret what is said to us. The problem is how to give the computer just the right 'experience' to be able to put what it hears into context and reach an understanding of the message.

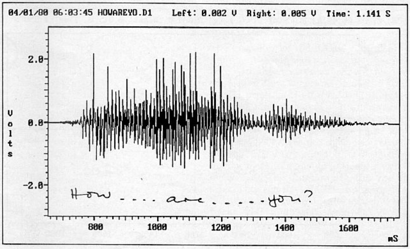


Fig. 3. Waveform of the sentence "How are you?" Because the consonants are spoken in much the same way as we speak vowels, the words are blurred together.

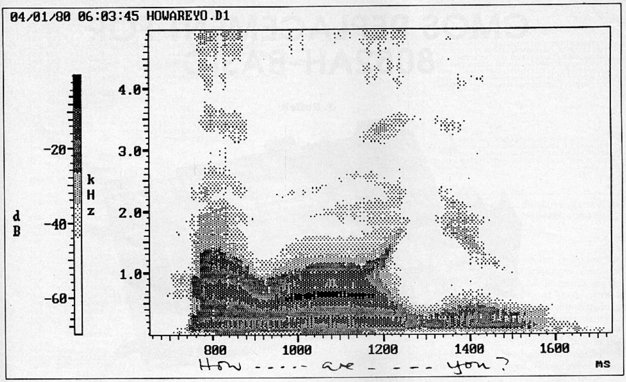


Fig. 4. Analysed version of the waveform in Fig. 3. For this phrase the segmentation of individual sounds and words is by no means obvious.

But even if we are able to limit the topic of conversation in such a way that the computer stands some chance of understanding what is said to it, there is also the difficult task of converting the sound it hears into the sentences it must understand. Figure 1 shows the acoustic signal of the spoken sentence "it's a black cat." In the waveform, time runs from left to right and it is easy to spot, by looking at the way in which the amplitude of the tracing changes, the individual words in the sentence. Labelling this signal is not at all difficult because it is naturally segmented. It consists of alternating consonants (without loud vocal cord vibration) and vowels (with loud vocal cord vibration). It is the alternation that results in the widening and narrowing of the trace. Figure 2 shows the acoustic analysis the computer performs on the same sentence, producing a kind of map of the inner details of the signal. Once again, the boundaries between the words are easily detected.

Sentences are rarely this easy to segment, however. In Fig. 3 we see the waveform of the sentence "How are you?" Although in the spelling of this sentence we see orthographic consonants and vowels alternating, the particular consonants here (w, r, y) are spoken in much the same way as we speak vowels. The result is a blurring together of the words, making it almost impossible to spot the boundaries between them. If we look at Fig. 4, which is the analysed version of the same sentence, we can see that the segmentation of the individual sounds and words that make up the phrase is by no means obvious.

Synthesizing the response

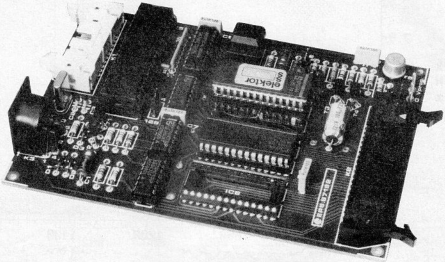
The easiest component of the system is the synthesis of the message the computer has generated in response to what it has heard. Assuming the problems of the earlier stages have been overcome and that the computer has formulated what it wants to say, the response must now be spoken. In some sense the task here is the opposite of the labelling one: the computer has generated the right labels and arranged the words to form a sentence, and now the acoustic signal has to be generated. The building blocks used to form the spoken sentence are individual sounds but, as we saw above, people do not speak sequences of isolated sounds. They run them together. Blurring the boundaries between speech segments forms the basis of good speech synthesis, and success depends on accurately generating the different types of blurring, as shown by Figures 1 and 3.

Conversations with computers will be a success only when everything is as natural as between two human beings. Each of the stages described above can now be accomplished with varying degrees of success, and we have complete systems in operation in the laboratory. But they are unnatural in that, for example, the computer cannot detect the subtleties hidden within human speech nor reproduce them when it speaks. These subtleties largely communicate peoples' attitudes, feelings or emotions. We can say the simple word "hello" in such a way that it communicates how pleased we are to see someone; or how relieved we are they have shown up; or how angry we are; or how surprised, and so on. Research is well under way to determine just how a person communicates such emotive subtleties in speech, and how these can be detected and reproduced by the computer. Preliminary results of incorporating this research into our conversational simulations show naturalness to be considerably improved.

It will be some time before holding what seems a quite natural conversation with a computer will be a common everyday occurrence. But already, computers that understand us and can respond by speaking back are beginning to make their appearance. In certain restricted areas, such as information services available over the telephone, experimental systems are already in use. Banking transactions and airline time-table services are the first of such systems becoming available, and as we improve the conversational abilities of the computer we shall see a rapid expansion of interaction between human beings and computers, not using keyboards and screens but natural-sounding speech.

CMOS REPLACEMENT FOR 8052AH-BASIC

J. Ruffell



Simple to program and implement for a wide range of applications requiring intelligent control, the BASIC computer described roughly two years ago is now due for a modification that reduces its current consumption by a factor of four. A small BASIC program written for the occasion, a terminal or PC running a terminal emulation program, an Intel-hex compatible EPROM programmer and a 27C64 form the ingredients to perform an interesting trick.

The project described in Ref. 1 is a euro-card-size (10×16 cm) BASIC computer with some remarkable features, which include an on-board EPROM programmer, a machine code run option for fast turnkey applications, and a simple terminal interface. This computer is based on Intel's Type 8052AH-BASIC V1.1 single-chip microcontroller with an on-board BASIC interpreter. Interestingly, similar BASIC computers and associated development systems based on the 8052AH-BASIC were offered as ready-made units by a number of companies in the UK some time after our publication.

Many constructors of the BASIC computer have noted that the 8052AH-BASIC microcontroller is the only non-CMOS integrated circuit in the BASIC computer, and have been enquiring after a low-power equivalent to reduce the overall current consumption of the board. Unfortunately, Intel have expressed no intention to market a CMOS version of the 8052AH-BASIC.

There is, however, a way to reduce the current consumption of the BASIC computer significantly. Bearing in mind that the 8052AH-BASIC is the only member of the MCS-51® family of microprocessors and microcontrollers that has an internal ROM containing a BASIC interpreter, it should be possible to use a similar processor, a 80C32, in conjunction with an external EPROM that contains the BASIC interpreter. This replacement offers two advantages over the single 8052AH-BASIC chip: first, the current consumption of the BASIC computer is reduced from about 150 mA to 38 mA; and second, the combination of a 80C32 and an external EPROM Type 27C64 costs less than a 8052AH-BASIC. The one disadvantage should also be mentioned: the combination of the 80C32 and the 27C64 does not provide the EPROM programming facility available in the original BASIC interpreter. In most cases, however, an unmodified 8052AH-BASIC computer will remain available for writing and debugging turnkey programs. As before, these may be loaded into EPROMs for use with other systems, such as a 80C32-, 8051- or 8052-based computer.

Unloading BASIC V1.1

The general idea is simple: make a copy of the ROM-resident BASIC interpreter in the 8052AH-BASIC, and store this copy in an 8 Kbyte CMOS EPROM. Add the 80C32 and you have a low-cost CMOS equivalent of the 8052AH-BASIC.

The program listed in Fig. 1 enables the machine code that forms the BASIC interpreter in the 8052AH-BASIC to be downloaded to a terminal, or a PC that acts like a terminal. The code is formatted to the Intel-hex standard, which can be handled by almost any EPROM programmer.

The terminal connected to the BASIC computer must be VT52-, VT100-, or ANSI-compatible, and in addition provide a spool or log function. An MSDOS computer running a communications program such as Procomm® is also suitable.

Start up the BASIC computer as usual, and enter the program UPLOADER.BAS in Fig. 1 on the terminal, paying attention to the commas and other punctuation marks that are significant for the BASIC interpreter (a comma suppresses the normal CR/LF sequence). If you use a PC, type the program into your favourite wordprocessor, check it against the listing, and store it on disk in ASCII format (the PCTools wordprocessor is fine for this purpose). Next, use SENDBAS.EXE (see Ref. 1) or the communications program to transfer the file to the BASIC computer.

```
100 REM  ************************************************
110 REM  **  INTERPRETER UPLOADER 8052-AH-BASIC V1.1   **
120 REM  **  OUTPUT FORMAT:     INTEL INTELLEC 8/MDS    **
130 REM  **                :    16 (10H) BYTES/RECORD  **
140 REM  **  VERSION       :    PJR1.0                 **
150 REM  **  DATE          :    11/10/89               **
160 REM  ************************************************

170 STRING 2500,11
180 REM STRINGS FOR DECIMAL TO HEX CONVERSION
190 $( 0)="0": $( 1)="1": $( 2)="2": $( 3)="3"
200 $( 4)="4": $( 5)="5": $( 6)="6": $( 7)="7"
210 $( 8)="8": $( 9)="9": $(10)="A": $(11)="B"
220 $(12)="C": $(13)="D": $(14)="E": $(15)="F"
230 REM HEADER AND NUMBER OF BYTES PER RECORD
240 $(16)=":10"
250 REM NORMAL RECORDTYPE
260 $(17)="00"
270 REM LAST RECORD
280 $(18)=":00000001FF"

300 REM START UPLOADER
310 FOR BASEADDR=0000H TO 1FF0H STEP 10H
320   REM OUTPUT HEADER AND NUMBER OF BYTES PER RECORD
330   PRINT $(16),
340   REM SPLIT BASE ADDRESS IN HIGHBYTE AND LOWBYTE
350   HIGHBYTE=(BASEADDR.AND.0FF00H)/256
360   LOWBYTE =(BASEADDR.AND. 00FFH)
370   REM OUTPUT BASE ADDRESS
380   OUT=HIGHBYTE: GOSUB 1000
390   OUT=LOWBYTE : GOSUB 1000
400   REM OUTPUT RECORDTYPE
410   PRINT $(17),
420   REM INITIATE CHECKSUM
430   SUM=10H+HIGHBYTE+LOWBYTE
440   REM READ 16 INTERPRETER BYTES STARTING FROM BASE ADDRESS
450   FOR OFFSET=00H TO 0FH
460     REM READ AND OUTPUT BYTE
470     OUT=CBY(BASEADDR+OFFSET): GOSUB 1000
480     REM UPDATE CHECKSUM
490     SUM=SUM+OUT
500   NEXT OFFSET
510   REM CALCULATE AND OUTPUT CHECKSUM
520   SUM=(NOT(SUM)+1).AND.00FFH
530   OUT=SUM: GOSUB 1000
540   REM PREPARE NEXT RECORD
550   PRINT
560 NEXT BASEADDR
570 REM OUTPUT LAST RECORD
580 PRINT $(18)
590 END

1000 REM HEX OUTPUT ROUTINE
1010 REM ******************
1020 REM CONVERT 'OUT' INTO A HEX-PAIR (HIGHN,LOWN) AND OUTPUT THE CHARACTERS
1030 HIGHN=INT(OUT/16)
1040 LOWN =OUT-HIGHN*16
1050 PRINT $(HIGHN),$(LOWN),
1060 RETURN
```

900009 - 11

Fig. 1. Listing of UPLOADER.BAS, a program that enables the ROM-resident BASIC interpreter in the 8052AH-BASIC microcontroller to be copied to a PC or terminal.

```
:1000000061873720312DC0D0024003C0D0202E1090
:1000100002400B20122BC0D0024013C0D0021F7828
:10002000218FCC0D0201F1C024023C0D002402B6D
:1000300002193620260 8C29630B2FDD2963202202E
:100040040D21632022050177E120E0FE00FD60457
:100050009506D206B9069F13971316119B173813EE
:10006000F5171314831 46F1478138C13C613D2135B
......
      ......
            ......
                  ......
                        ......
                              ......
:101FC00045204E554D42455222250524F4D204D4FC7
:101FD000444 5222A4D43532D353128746D29204222
:101FE00041534943205631 2E312A22B16CB43A0074
:101FF000400122B43000B3224552524F523A2022BF
:00000001FF
```

900009 - 13

Fig. 2. Hexdump of the start and end of the Intel-hex file sent by the BASIC computer.

Experienced users of the BASIC computer may also consider having the 8052AH-BASIC store the program in EPROM.

Turn on the log function of the terminal, or the download function of the comms program on the PC, and type command RUN. An Intel-hex file is subsequently sent from the BASIC computer to the terminal or PC. When reception is complete, save the file, then examine it with a wordprocessor. Go to the beginning and remove the command RUN, which has been loaded because the log (download) function was active at the time it was typed. Save the corrected file.

The downloaded file is 23,054 bytes long, and ready for uploading to an EPROM programmer that can handle the Intel-hex file format. The hexdump in Fig 2 shows the start and the end of the file for reference purposes (the RUN command has been removed). Check the listed bytes against those in your file to make sure this has been loaded correctly.

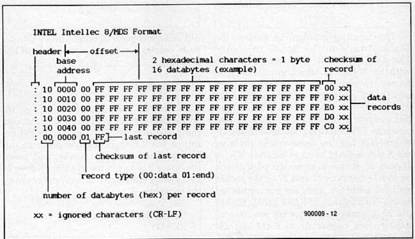
About the Intel-hex format

Although the Intel-hex format is supported by most commercially available EPROM programmers, some users of the BASIC computer may require details on the file structure to write a conversion program that converts the file downloaded from the BASIC computer into binary format.

As shown in Fig. 3, an Intel-hex file consists of records that in turn consist of 16 (10H) databytes. All numbers are in hexadecimal. Each record starts with a header, which consists of a colon (:) and a byte that indicates the number of databytes in the record. This byte can have a value smaller than 10H (16D) only in the last record. The header is followed by the address of the record. For all records except the last one, this address is incremented in 16-byte steps, although it is possible to skip certain portions of the address range. The function of the 'record type' byte is clear from the drawing. The checksum record that follows the 16 databytes is the least significant byte of the two's complement of all the bytes in the record from the byte count number to the last databyte. The last record is marked by the '01' type marker. In the example shown in Fig. 2, it contains no databytes.

Hardware

Assuming that a Type 2764 EPROM has been successfully loaded with the interpreter code, it is time to turn to the hardware of the BASIC computer.


INTEL Intellec 8/MDS Format
header
offset
base address
2 hexadecimal characters = 1 byte
16 databytes (example)
checksum of record
data records
last record
checksum of last record
record type (00:data 01:end)
number of databytes (hex) per record
xx = ignored characters (CR-LF)
900009 - 12

```
: 10 0000 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF 00 xx
: 10 0010 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF F0 xx
: 10 0020 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF E0 xx
: 10 0030 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF D0 xx
: 10 0040 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF C0 xx
: 00 0000 01 FF
```

Fig. 3. Intel-hex record format.

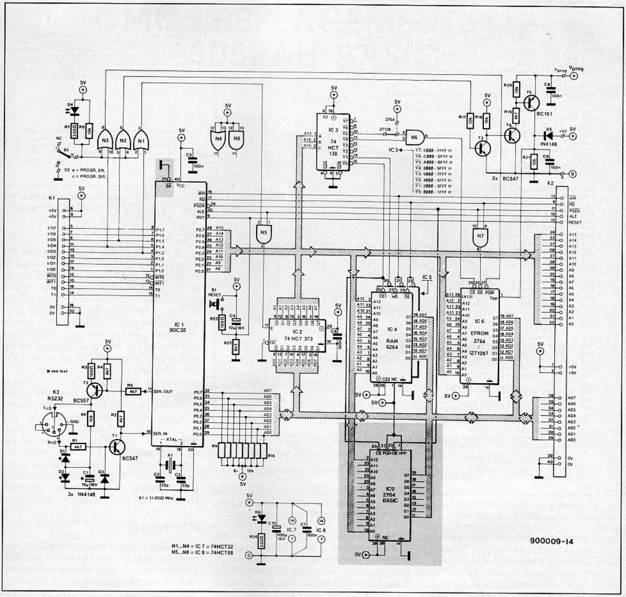


Fig. 4. Circuit diagram of the modified BASIC computer. The 27C64 EPROM that contains the BASIC interpreter is connected virtually in parallel with the existing system RAM, IC4.

The circuit diagram in Fig. 4 shows the changes made to the BASIC computer. The 8052AH-BASIC has been replaced with an 80C32 of which pin 31 is connected to ground. Cut the track from pin 31 to the supply voltage, and connect pin 31 to ground with the aid of a small piece of wire. With the exception of two pins, the EPROM that contains the BASIC interpreter has the same connections as the 8 Kbyte RAM used in location IC4. A 28-way IC socket is mounted piggy-back on to IC4, but pins 22 and 27 of the socket are bent aside (i.e., they are not connected to the corresponding RAM pins). Socket pin 27 is connected to socket pin 28, and the two are connected to RAM pin 28. Socket pin 22 is connected to pin 29, PSEN of the microcontroller. Finally, connect pin 1 of IC4 to the positive supply with the aid of a short piece of wire. The +5 V track runs nearby pin 1 at the track side of the board.

Ready for use

Remove the 8052AH-BASIC from its socket and replace it by the 80C32. Mount the programmed 27C64 in the socket on top of IC4. Connect the computer to the terminal or PC, apply power, and press the space bar to get the system on line. If everything is all right, the computer sends the message

```
*MCS-51(tm) BASIC V1.1
READY
>
```

You are now ready to use the BASIC computer. Remember, however, that the EPROM programming facility is no longer available in BASIC. Switch S2 on the board must, therefore, left in the 'program disable' position.

Reference:

1. BASIC computer. *Elektor Electronics* November 1987.

For further reading:

1. Single-chip microcontrollers. *Elektor Electronics* September 1987.
2. Peripheral modules for BASIC computer. *Elektor Electronics* October 1988.

HCMOS OSCILLATORS

by J. Ruffell

HCMOS integrated circuits were originally intended for the design of fast, low-power-consumption digital circuits. In practice, these devices have proved to be suitable for a number of other applications as well. This article describes how they may be used in the design of simple, yet reliable, *RC* and crystal oscillators.

HCMOS integrated circuits are devices that work fast, are economical in power consumption, operate without any problems from a range of supply voltages, and have a threshold voltage that is pretty stable over a wide range of operating temperatures. These parameters make them eminently suitable for designing stable, reliable oscillators. In practice, these oscillators are normally of the *RC* type; if very stable and precisely defined frequencies are needed, the *RC* network must be replaced by a crystal.

Because HCMOS gates possess a very high input impedance, capacitors with a wide range of values may be used in the *RC* network. Even more important is perhaps that capacitors of very low value may be used, so that little energy is lost during operation.

Basic circuit

The basic circuit of an oscillator designed from two inverters and the waveforms that occur in the circuit are shown in Fig. 1. Because of the inversion in the two gates, it is certain that the polarity of the voltages at A and B is opposite to that of the potential at C.

To keep the description simple, it will be assumed that the potential at A and B is low and that at C is high. Capacitor *C* is charged via resistor *R* until the voltage at B reaches the switching level of the inverter, V_{ST}. The potential at C then becomes low and that at A high.

Since the level at the output varies rapidly, the level of the potential at B should become $V_{ST} + V_{CC}$. However, the input of the inverter is protected by a diode, so that the voltage at B can not exceed $V_{CC} + V_D$, in which V_D is the potential drop across the diode. Conversely, the maximum level of the negative voltage in the circuit can not exceed $0 - V_D$, and this occurs when the output of inverter 2 becomes low. The voltage at B rises from that level to V_{ST}; only when that level is reached, does the output of inverter 1 become low again. The time constant, $\tau = RC$, determines the charging and discharging periods of the capacitor:

$$\tau_1 = -RC \ln\{V_{ST}/(V_{CC} + V_D)\}; \qquad [1]$$

$$\tau_2 = -RC \ln\{(V_{CC} - V_{ST})/(V_{CC} + V_D)\}; \qquad [2]$$

$$f = 1/(\tau_1 + \tau_2). \qquad [3]$$

The values of τ are in seconds and that of f, the frequency at which the oscillator begins to operate, is in hertz.

External influences

For Type 74HC/HCU circuits, the manufacturers state that V_{ST} is typically half the supply voltage, V_{CC}. Since $V_D = 0.7$ V, a quick calculation shows that the frequency drift varies from +9% to −2.5% if the 5 V supply voltage varies from 3 V to 6 V. The inequality of the positive and negative drift is caused by the constancy of the potential drop across the diode, irrespective of the level of the supply voltage. This constancy is important in the calculation of τ_1, because the term in brackets in formula [1] will vary when the supply voltage varies in spite of V_{ST} being a fixed percentage of the supply voltage. The frequency vs supply voltage characteristic is given in Fig. 2.

Although the manufacturers state that the threshold voltage is typically 0.5 V_{CC}, in practice it appears that its value lies between 0.3 and 0.7 in case of the HC family and between 0.2 and 0.8 in case of the HCU family. This means that the frequency drift of HC oscillators is not greater than 9.5%, but that of HCU oscillators may be as high as 21.5%.

The frequency vs threshold voltage

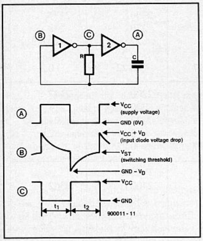


Fig. 1. Basic circuit of an *RC* oscillator designed from two digital inverters.

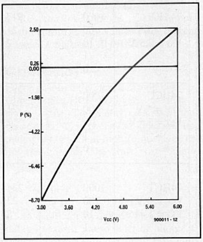


Fig. 2. Oscillator frequency vs supply voltage.

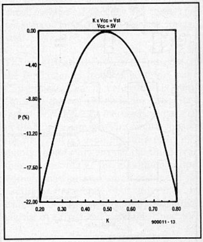


Fig. 3. Variations of the threshold voltage affect the oscillator frequency.

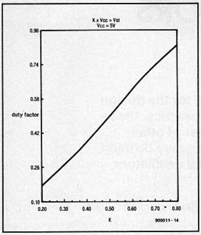


Fig. 4. In *RC* oscillators designed around HC or HCU inverters, the duty factor is highly dependent on the level of the threshold voltage.

characteristic is given in Fig. 3. It is interesting to note that a deviation of the threshold voltage from its nominal value always results in a lowering of the frequency. As shown in Fig. 4, the duty factor is also affected by such a deviation; only in the ideal case, that is, when the threshold voltage is equal to half the supply voltage, will the duty factor be 50%.

In the above, ICs from the HCT family have not been considered, because their switching behaviour is rather more precise than that of devices in the other two families. Moreover, HCT circuits may be used only with supply voltages of 4.5–5.5 V, and with these the threshold voltage varies relatively little. This results in a maximum frequency drift of not more than ±0.8% over the specified operating range, while the duty factor remains fairly constant at around 75%. The asymmetric behaviour here is caused by the threshold voltage not being centred around half the supply voltage. In practice, it is found that the maximum deviation of the threshold voltage, when the supply voltage is 5 V, causes a frequency drift of not greater than 16%.

Improved stability

Adding a resistor, *Rs*, to increase the input impedance of inverter 1, as shown in Fig. 5, makes the circuit a great deal more stable. The additional resistance increases the discharge period of capacitor *C*, and causes the threshold voltage of the protection diode to have less influence on the operation of the circuit. If the value of *Rs* is chosen high enough, the waveforms shown in Fig. 5 will ensue. Note that the voltage at B varies around the threshold voltage at a value equal to *V*cc. Too low a value of *Rs* may result in clipping of the voltage peaks, while too high a value may, in conjunction with *C*t1, cause spurious oscillations. At an optimum value of the resistor, the variations of the duty factor and the frequency are reduced by some 30%, irrespective of whether HC, HCT or HCU devices are used.

It appears that ICs in the 74HCU series, because their outputs are not buffered, are particularly suitable for this type of oscillator.

In general, it appears that the optimum value of *Rs* is equal to 2*R*. At this value of *Rs*, the time constants are:

$$\tau_1 = -RC \ln\{V_{ST}/(V_{CC} + V_{ST})\}; \qquad [4]$$

$$\tau_2 = -RC \ln\{(V_{CC} - V_{ST})/(2V_{CC} - V_{ST})\} \quad [5]$$

while the period of oscillation, *T*, is:

$$T = -RC \ln\left[\frac{V_{ST}(V_{CC} - V_{ST})}{(V_{CC} + V_{ST})(2V_{CC} - V_{ST})}\right] \qquad [6]$$

From this formula, it is seen that the diode voltage no longer affects the period. If ICs from the 74HC or 74HCU families are used, so that *V*ST is roughly 0.5*V*cc,

$$T = 2.2RC. \qquad [7]$$

Because of the different value of *V*ST in HCT circuits (where it has a fixed value and is not a percentage of the supply voltage), a small correction is necessary and this makes the period:

$$T = 2.4RC. \qquad [8]$$

Formulas [7] and [8] are approximations, but in practice they prove to be very close to the measured value. The measured and calculated values are summarized in Table 1 (in which *Rs* = 2*R*).

The astable multivibrator functions well if bipolar capacitors with a value of not less than 100 pF are used. Moreover, formulas [7] and [8] are usable only if the parasitic capacitances may be ignored: this is so when the capacitor is greater than 10 nF. Resistor *R* may have a value of between 1 kΩ and 1MΩ.

Use of crystal

If a very stable oscillator is needed, it should be controlled by a crystal instead of an *RC* network. A crystal has the further advantage that it is much more suitable than *RC* networks for generating high frequencies. Also, if a crystal is used in an HCMOS circuit, it requires very little power. This explains the popularity of

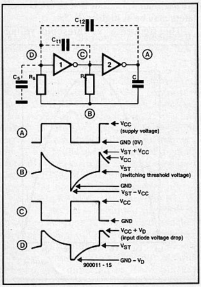


Fig. 5. A second resistor makes the oscillator far more stable.

	τ	*T* (computed)	*T*=2.2τ	*T* (measured)
74 HC	1000	2174	2200	2177
*V*cc = 5 V	100	217	220	218
*V*ST = 2.5 V	10	21.7	22	22.6
	1	2.17	2.2	2.4
	0.1	0.217	0.22	0.3
74HCU	1000	2174	2200	2147
*V*cc = 5 V	100	217	220	214
*V*ST = 2.5 V	10	21.7	22	21.7
	1	2.17	2.2	2.4
	0.1	0.217	0.22	0.3
			T=2.4τ	
74HCT	1000	2348	2400	2362
*V*cc = 5 V	100	235	240	236
*V*ST = 1.415 V	10	23.5	24	24.4
	1	2.35	2.4	2.6
	0.1	0.235	0.24	0.3

Table. 1. In practice, the difference between computed and measured values is found to be small.

HCMOS / crystal oscillators.

The electrical equivalent of a crystal is shown in Fig. 6. It consists of an inductance, a resistance and two capacitances.

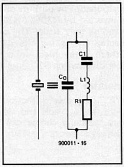


Fig. 6. Equivalent electrical circuit of a crystal.

The circuit has a series- as well as a parallel-resonant frequency, and this must be borne in mind during the design of the oscillator. The crystal manufacturer always indicates whether a crystal has been cut for series or parallel operation. In the final instance, the position and value of capacitance C_L determine in which mode the crystal will oscillate (see Fig. 7).

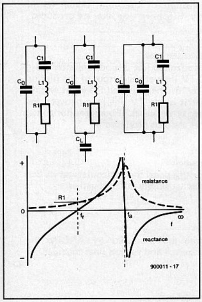


Fig. 7. Dependent on the load, a crystal may jump from one mode of operation to another. At the left, the equivalent circuit of the crystal; at the centre, the equivalent circuit for series-resonant operation; at the right, the equivalent circuit for parallel-resonant operation.

Series-resonant oscillators are designed to oscillate near the resonance frequency, f_r, of the crystal. Parallel-resonant oscillators operate at a frequency that depends on the capacitance of the shunt capacitor and lies somewhere between f_r and the so-called anti-resonance frequency, f_a. This is the reason that in practical circuits part of the load capacitance is formed by a variable capacitor.

The Pierce oscillator in Fig. 8 uses a Type 74HCU04 chip (which is not buffered since buffered devices can not be used here). Boffins will recognize the circuit as a Colpitts oscillator in which the inductance has been replaced by a crystal. This type of oscillator uses very little power and offers good suppression of third harmonics.

The latter characteristic is important, because many oscillators have a tendency to jump to harmonic frequencies.

Although the circuit may be used with a supply voltage of 2 V, it is recommended not to use supplies below about 3 V. The maximum supply voltage is 6 V.

Owing to the low output impedance of the ICs, they can not be connected direct to the crystal, and it is, therefore, necessary, to add a resistance in the output to raise the impedance. Unfortunately, this resistance may introduce a phase shift, and its use above 4 MHz is, therefore, not recommended. Instead, a capacitance must be used: the value of this for use with most crystals is about 30 pF. Here, since C_{L1} and C_{L2} are in series, the buffer capacitor should have a value of about 56 pF.

For optimum operation of the Pierce oscillator, its output impedance must be equal to the impedance of the frequency-determining network. This load impedance, Z_L is approximately

$$Z_L = X_{CL}^2/R_r \qquad [9]$$

in which X_{CL} is the reactance of capacitor C_{L2} and R_r is the resistance of the crystal at resonance: in practice, this is 75 Ω.

In theory, the optimum value of R_L in a 4 MHz oscillator is 5900 Ω, whereas the impedance of the output gate is only about 40 Ω. A practical value of 5600 Ω results in too high a phase shift: a compromise value is found to be 2200 Ω.

Resistor R_f sets the DC operating point of the amplifier; its value is not critical: between 1 MΩ and 10 MΩ is fine.

Gate delay

Every gate in an IC has a certain delay, t_p, which in fast HCUMOS gates amounts to about 14 ns. This delay causes a small phase shift, Φ, between the input and output signal, which at high frequencies can not be ignored. The shift is calculated from:

$$\Phi = f\, t_p \times 360° \qquad [10]$$

At an oscillator frequency of 6 MHz, the delay causes a phase shift of 30° which, coupled with the phase shift introduced by R_s, causes the Pierce oscillator to stop. If the resistor is replaced by a capacitor whose value is equal to that of C_L, the total phase shift is brought back to a value that allows the oscillator to work correctly.

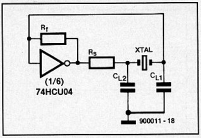


Fig. 8. Basic circuit of a Pierce oscillator using only one gate. Two additional resistors ensure that the gate operates as an amplifier. Resistor *Rf* provides the DC operating point of the amplifier.

Finally

Crystal manufacturers cut crystals for use in high-frequency oscillators in a manner that allows the crystals to oscillate at an harmonic. Crystals for operation at 10–75 MHz oscillate at the third overtone. At higher frequencies, 50–125 MHz, crystals are used that oscillate at the fifth harmonic.

To use these crystals, the circuit needs a small modification as shown in Fig. 9.

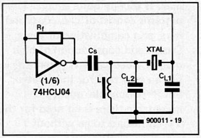


Fig. 9. This small modification ensures that the circuit operates satisfactorily with crystals that are intended for operation at harmonic frequencies.

The modification ensures suppression of the fundamental frequency in two ways. Capacitor C_s has a value that is about equal to that of C_L and thus presents a higher impedance to the fundamental than to the third overtone. The circuit consisting of L and C_s oscillates at a frequency that is slightly lower than the third overtone. Adjusting L for maximum output voltage may cause a small change in the oscillator frequency, but this may be trimmed out by C_L, which in practice will consist of a fixed and a variable capacitor.

video pattern generator

P. Needham

TV technicians often make use of a video pattern generator to help set up television sets quickly and simply. Pattern generators (normally) produce a video signal which complies with CCIR standards. The video information itself is usually quite simple. The patterns consist of lines, dots and bars, or a combination of them. Design and construction of high quality video pattern generators is not an easy task for the amateur, but if 'reasonable' quality is acceptable there is no need for the TV enthusiast to go without.

To give a clearer indication of how the unit works, the circuit diagram has been divided into four sections which each carry out a certain function. Block A takes care of the synchronisation pulses. Block B provides the sound output and grey scale circuitry. Block C contains the logic required to produce the various patterns and block D comprises the video stage.

Sync generator

The crystal oscillator formed around N3 provides a 1 MHz signal which is divided by IC14 to produce the required 250 kHz input signal. This is then further divided by IC1a to obtain the line frequency (15,625 Hz). The field frequency is produced from the counters IC1b, IC2a and IC2b which twice divide the line frequency (31250 Hz) by 625 to give the required 50 Hz. These counters also control three timers (IC3b, IC4a and IC4b) which, after being triggered by IC3a (the front porch delay), provide the line sync pulse, the field sync pulse and the equalisation pulses. The enable signal for IC3b is also gated with the 12 µs line blanking pulse (from N4) to ensure correct synchronisation with the line frequency. The flipflop N11/N12 produces the field blanking interval and is reset after every 25 lines. The blanking pulses and the output from the pattern generator are gated by N9 to provide a blanked video drive to the mixer stage.

Sound output

The sound output circuitry consists of little more than a divide-by-sixteen counter, IC12a. This produces a tone of 977 Hz from the line frequency. The amplitude of the output signal is attenuated by R12 and P1 and filtered by C7 to produce a more pleasant sound.

Grey scale

The grey scale is produced by a gated oscillator constructed around N2/N9 and a binary counter IC12b. During line and field blanking intervals the oscillator is inhibited and the counter is reset to zero to ensure that each new line is correctly positioned. The outputs of the counter are inverted by N30 . . . N32 to give a descending grey scale. The grey scale is selected by taking the other inputs of these gates high, in other words by operating switch S1.

Pattern generator

The pattern generator (section C) produces eight basic black and white patterns from which a choice can be made with the aid of a rotary switch.

Vertical lines

The Q1 output of the grey scale counter (IC12b) is connected to N19 which generates a short output pulse at each transition of the input signal. In this way, fifteen vertical lines are produced.

Horizontal lines

A horizontal line is produced after every 20 TV lines at the output of the flipflop N15/16. The gating on the input ensures that it is one TV line long between the line sync pulses. Fourteen horizontal lines are thus produced.

Crosshatch

For this signal the horizontal and vertical lines are simply ORed together.

Dots

These are produced by ANDing the horizontal and vertical lines together.

Vertical bars

This is the output of the grey scale oscillator (N2 and N29) and gives sixteen vertical bars.

Horizontal bars

The Q3 output of the field counter (IC12a) gives thirteen horizontal bars.

Chessboard

By connecting the horizontal and vertical bar signals to the EXclusive NOR gate N20 a chessboard effect is produced.

1

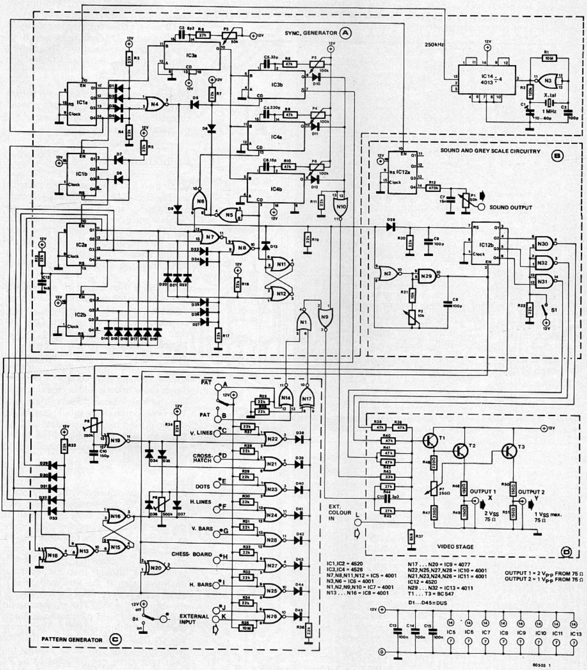


Figure 1. The complete circuit diagram of the video pattern. It is divided into four sections for clarity. A UHF/VHF modulator can be connected directly to the output of the video stage.

External

Provision has been made so that an external pattern signal can be connected to the system via gate N26.

As can be seen, the eight patterns are connected to gates N21 . . . N28. By taking the unused inputs of these gates low the required pattern can be selected. Gates N14 and N17 allow the choice between 'normal' and 'inverted' patterns. The number of patterns can be extended by selecting several basic patterns together (vertical lines with horizontal bars) or more complex patterns can be produced by utilising the binary outputs of IC12b.

2

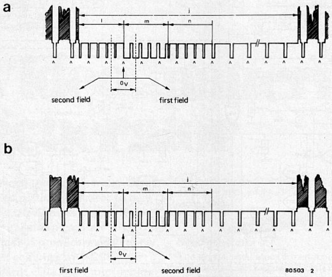


Figure 2. A general idea of what the composite video signal should look like. Figure 2a shows the first field and figure 2b the second.

Parts list:

Resistors:
R1,R35 = 10 M
R2 = 120 k
R3,R4,R5,R7,R11,R13,
R17 . . . R20, R22 . . . R34,
R36 = 22 k
R6,R8,R9,R10,
R38 . . . R42 = 47 k
R12 = 470 k
R37 = 6k8
R43 = 33 k
R44,R45 = 27 k
R46 = 220 Ω
R47 = 330 Ω
R48 . . . R51 = 150 Ω
(R14,R15 and R16 have not been used)

Capacitors:
C1 = 10 . . . 60 p
C2,C8,C9 = 100 p
C3 = 8p2
C4 = 330 p
C5 = 33 p
C6 = 15 p
C7 = 15 n
C10 = 150 p
C11 = 3p3
C12 = 1n5
C13 . . . C15 = 100 n

Semiconductors:
T1 . . . T3 = BC547
D1 . . . D45 = DUS
IC1,IC2,IC12 = 4520
IC3,IC4 = 4528
IC5 . . . IC8,IC10,IC11 = 4001
IC9 = 4077
IC13 = 4011
IC14 = 4013

Miscellaneous:
S1 = single pole switch
S2,S10 = single pole toggle switch

Video stage

In section D the digital input signals are mixed together by the resistor network R37 . . . R45. The composite video signal is then buffered by T1 which drives transistors T2 and T3 to provide two different output levels. The output of T3 can be adjusted by potentiometer P7. Capacitor C11 has been added to improve picture stability. The output from the mixer can be fed to a suitable TV modulator.

The complete video waveform is shown in figure 2 and figure 3 gives the printed circuit board and component layout for the pattern generator.

Calibration

Initially, potentiometers P3 . . . P6 are set to their mid position and no patterns are selected. The grey scale is switched on with S1 and S2 is placed in the 'invert' position ($\overline{\text{PAT}}$). Potentiometer P2 can then be adjusted so that eight grey bars of different intensity appear on the screen. The lightest and darkest bars should be at opposite sides of the picture.

Switch S1 is then turned off and vertical lines selected. Potentiometer P9 is then adjusted to give 15 narrow, black, vertical lines on the screen. Dots are then selected and P8 adjusted to give 15 columns.

The CCIR standard can be approached by using an oscilloscope. Potentiometers P3, P4, P5 and P6 control the front porch delay, the field sync, the line sync and the equalisation pulses respectively. The front porch delay should last 1.5 μs, the field sync pulse should last 27.3 μs, the line sync pulse should be 4.7 μs wide and the equalisation pulses should be about 2.35 μs wide.

In some cases the line and field sync pulses can be brought onto the TV screen by switching on the grey scale, switching S2 to 'normal' (PAT) and selecting horizontal lines. The width of the line sync pulse appearing vertically in the picture can be adjusted by P5 until it amounts to 40% of the width of the grey blanking pulse. Potentiometer P3 should then be adjusted until the start of the line sync pulse is about 12.5% away from the left edge of the blanking pulse. The thickening on the horizontal field sync pulse is due to the equalisation pulses. These are adjusted by P6 until they are half the width of the line sync pulse. Finally, the field sync pulse can be adjusted by P4 so that the width of the gap in the beam is equal to the width of the line sync pulse.

The pattern generator produces interlaced pictures only. By removing D19 the interlacing disappears. The representation of an even or uneven field depends on random switch-on phenomena. This may be noticed by the occurence of half lines in the horizontal bar pattern. ◾

3

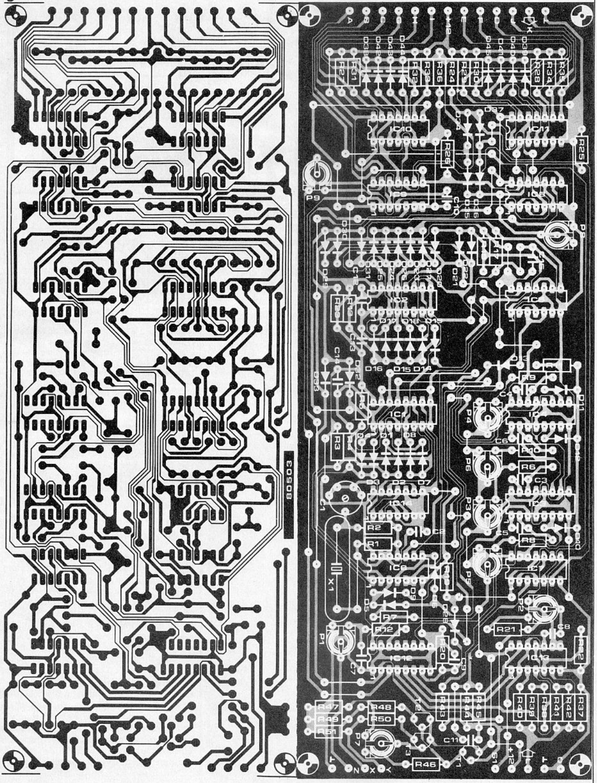


Figure 3. The printed circuit board and component layout for the video pattern generator.

safety first

The golden rule when confronted with mains powered electrical or electronic equipment is 'if you aren't 100% sure of what you are doing leave well alone'. In this article the steps taken to ensure the safety of home-built and commercial equipment are discussed, both from an electrical (shock hazard) and from a fire-risk point of view.

Readers frequently ask why more explicit wiring details of the mains input side of mains powered equipment are not given in Elektor articles. There are several reasons for this seeming omission.

In the first place, this would entail a great deal of repetition every month, thus wasting space that could be put to better use. In the second place, Elektor is read in many English-speaking countries where wiring standards are different from those of the UK, and what is correct for the UK market may not be correct for these other countries.

In the third place, anyone who understands the principles involved can wire up a mains powered circuit quite safely without any further details, whereas anyone who does not understand what he is doing should not attempt to build mains-powered circuits, no matter how explicit the wiring details. The only exceptions to this last remark are kits supplied by a reputable manufacturer, where the mechanical construction and mains wiring can be closely specified, and an industrial situation where unskilled personnel carry out mains wiring under supervision and subject to quality control checks.

The purpose of this article is to provide readers with the necessary information to enable them to wire and use mains-powered equipment safely.

Safety hazards

There are two principal hazards that may be encountered in electrical and electronic equipment, namely electric shock and fire hazards.

The currents required to cause physical injury or death are quite small compared to the currents that flow in many electrical and electronic circuits, and the effects of a 50/60 Hz AC current flowing through the body from arm to arm are listed in Table 1.

These figures are, of course, typical and the actual effect of a particular current will depend on the victim's state of health. A person with a weak heart is likely to succumb at a lower current than a healthy person.

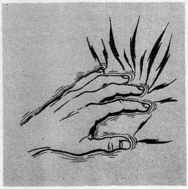


Table 1

Current	Effect
Below 500 μA	Little or no sensation
500 μA to 1 mA	Tingling sensation
1 to 5 mA	Slight pain
5 to 10 mA	Severe pain
10 mA to 100 mA	Muscular contraction (inability to let go)
100 mA to 2 A	Ventricular fibrillation (uncoordinated contraction of the heart muscle) — DEATH.
Above 2 A	Burns and physiological shock, but good chance of recovery.

The two most dangerous paths for current to take through the body are from arm to arm and from left arm to left leg, since in both cases the current passes directly through the region of the heart. A well-known safety rule is based on this: 'When working with high voltages, always keep your *left* hand in your pocket – even if you are left-handed!'.

Any current flow of more than a few milliamps through the body should be regarded as dangerous. Since the resistance of the body from arm to arm can be as low as 10 k if the palms of the hands are moist, this means that not only mains voltages, but also relatively low voltages can be dangerous. It is generally agreed that voltages in excess of 60 V DC or 42 V AC can constitute a shock hazard, since they could cause a current flow of some 5 or 6 mA through the human body.

Equipment housing

Electric shock can occur in a variety of ways. Current can flow through the body if contact is made with the supply and zero volt rails of a DC circuit or the two supply terminals of an AC circuit. This occurrence is prevented while equipment is in use by suitable physical construction, i.e. by a housing that prevents physical contact with any dangerous voltages.

If equipment must be ventilated to avoid overheating and consequent fire risk, the ventilation apertures must be

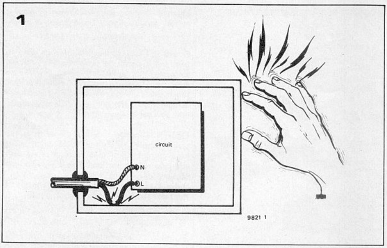


Figure 1. An unearthed metal case can become live in the event of an insulation failure.

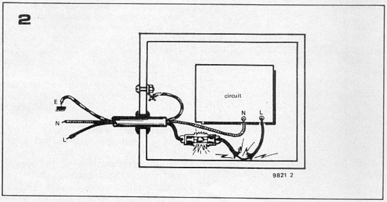


Figure 2. Earthing the case and placing a fuse in the live lead prevents a shock hazard, since the fuse will blow and disconnect the live input.

sufficiently small to preclude contact with dangerous voltages inside the housing.

Housings should be proof, not only against direct finger contact with dangerous voltages, but also against indirect contact via such things as necklaces which may inadvertently dangle through ventilation holes, or knitting needles wielded by tiny hands. British Standard tests for the safety of housings involve the use of a jointed test 'finger' of very slender dimensions and a thin chain 'necklace'. Only housings which have the ventilation holes covered with fine metal or plastic gauze can pass such tests.

When testing or repairing equipment with the housing removed the possibility of electric shock still exists. Obviously, power should be applied to unhoused equipment only for test purposes; for repair work the equipment should be unplugged, and in any case such work should be undertaken only by a competent person.

Earthing and double insulation

The second way in which electric shock can occur is by current flowing from a high-voltage point, through the body, to earth. In the U.K. mains system, the neutral lead of the mains wiring is at a voltage very close to true earth or ground potential (i.e. the

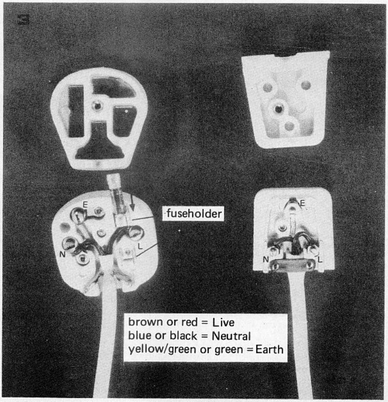


Figure 3. Correct wiring of three-pin mains plugs. If two-core cable is used then no connection is made to the earth terminal.

4

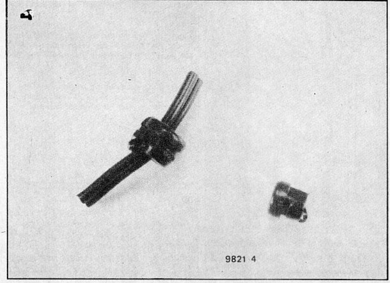


Figure 4. A strain relief bush prevents damage to the cable, which could cause a safety hazard.

5

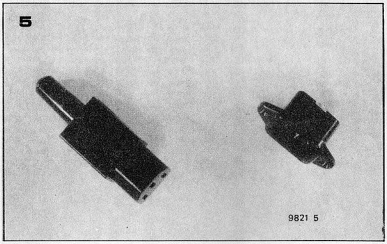


Figure 5. I.E.C. connectors may be used to feed mains power to equipment. In addition to preventing strain on wiring inside the equipment, there is also the advantage that the mains flex can be removed for storage of equipment, and cables of different lengths may be used if necessary.

Figure 6. Circuits powered direct from the mains supply (not via a transformer) must have current limiting resistors in series with any external connections. This is only feasible for very low current circuits.
Note that in the ioniser circuit (referred to in the text) the voltage is so high that resistor R must be replaced by a chain of 10 series resistors.

Figure 7. Low voltage circuits generally derive their power from a transformer which both steps down the voltage and provides electrical isolation from the mains input.

potential of the mass of the earth, which is taken as being zero volts) while the live lead alternates between positive and negative. If some part of the body is in contact with earth potential then electric shock may be incurred if another part of the body contacts the live lead. Electric shock from DC circuits may also occur in this way if the zero volt rail is tied to earth potential and the supply lead is inadvertently touched.

If the equipment is properly housed it will not be possible to touch the live lead or other high-voltage leads. However, if the equipment housing is of metal then an insulation breakdown within the equipment may cause the case to become live, as illustrated in figure 1. The occurrence of a shock hazard by this means can be prevented in one of two ways.

The first method is to construct the housing of insulating material so that, even in the event of an insulation failure within the equipment, the insulated housing provides protection against electric shock. If any metal parts are used in the construction they should not pierce the insulation of the case.

This type of construction is known as 'double-insulated', and it can be seen in many small domestic appliances where it is identified by the symbol ⧈. For the home constructor, this type of construction simply entails the use of plastic housings for equipment and the avoidance of metal hardware such as metal screws to fix components to the sides of the case. Items such as potentiometers with metal shafts and switches with metal fixing bushes or toggles should also be avoided.

Where a metal case must be used the second method of avoiding a shock hazard must be employed. This involves connecting the case to earth via the earth lead of the mains wiring, and placing a fuse in the live lead, as illustrated in figure 2. Should an insulation breakdown to the case occur, a large current will flow to earth, blowing the fuse and thus isolating the live lead. This method of construction, of course, means that a three-core mains lead must be used with live, neutral and earth conductors.

Earthed construction is frequently employed on larger domestic appliances such as washing machines and cookers.

It is perfectly possible to use a metal housing and double-insulated construction by having the electrical circuits surrounded by a second layer of insulation within the metal case. Even if there is a primary insulation breakdown this second insulation layer then prevents the case from coming into contact with high voltages.

This type of construction can be found in small domestic appliances such as food mixers, electric drills and some types of hi-fi equipment. However, it does require extreme care to make this type of construction totally safe, and it is not really suitable for the home constructor.

Care should also be taken to ensure that the mains wiring external to the equipment is safe. The mains lead used must be of a type having an outer sheath and two or three insulated conductors, depending on whether an earth lead is required or not. Twin core cable of the 'bell-flex' type, having only a single layer of insulation, should not be used for mains wiring.

The mains plug should be wired in accordance with figure 3, which shows both a 13 A fused plug and a 5/15 A unfused plug. Care should be taken to ensure that the cable strain relief clamp is gripping the outer sheath of the cable, to avoid any strain on the conductors.

Where the mains cable enters the equipment the hole should be bushed with a plastic or rubber grommet to avoid chafing, and the outer sheath of the cable should be clamped to avoid strain. These two functions may be combined in a strain relief bushing, as shown in figure 4.

Alternatively, connection to the equipment may be made via an I.E.C. chassis plug and cable socket, as shown in figure 5. In the event of the cable being tugged the plug and socket will simply disconnect.

Equipment with external connections

The discussion so far has assumed that the equipment was totally enclosed within its housing, with no part of the circuit being accessible from the outside. However, there is frequently a need for a circuit to have external connections, for instance equipment such as power supplies, oscilloscopes and other instruments.

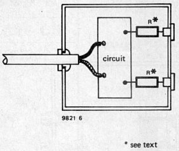
Equipment in which no part of the circuit is accessible from the outside may or may not contain a mains transformer, depending on the type of circuit. For example, a domestic appliance such as a hairdryer or foodmixer operates direct from the mains supply, whereas a digital clock or mains-powered transistor radio would probably contain a mains transformer to step down the voltage to that required by the electronic circuit.

However, if a piece of equipment has external connections then precautions must be taken to ensure that no dangerous voltage can appear on these connections, or if high voltages do appear then steps must be taken to limit the available output current to a safe value. An example of the latter practice is the ioniser circuit that appeared in Elektor 30, October 1977. The ioniser needle operates at a potential of around 7.5 kV, but a chain of series resistors limits the current to a few hundred microamps if the needle is inadvertently touched. This principle is illustrated in figure 6.

In a majority of cases, however, electronic circuits are low voltage circuits that derive their power from a mains transformer that steps down the mains voltage and also provides electrical isolation between the low voltage circuit and the mains input, as illustrated in figure 7. The transformer has independent primary and secondary windings, and there must be no direct electrical connection between them.

Of course, the possibility of an insulation breakdown between the primary and secondary must be considered, and there are two ways of preventing a shock hazard from this source. The first method is tó use a transformer which is double insulated. This type of insulation makes the possibility of an insulation breakdown between primary and secondary virtually impossible. Transformers of this type generally have a two-section bobbin made of an insulating material, the primary being wound on one half of the bobbin and the secondary or secondaries being wound on the other half. An example of construction using a split bobbin transformer is shown in figure 8.

6



Provided care is taken to ensure that no high-voltage part of the circuit can contact the low-voltage circuit, no earth connection is required. This can be ensured by a physical barrier between the high voltage and low-voltage sides of the circuit, which prevents contact even in the event of a mains wire coming adrift, or by double insulation of the high-voltage wiring, as shown dotted.

If double insulated construction is employed on the high-voltage side of the circuit then a metal case may be used if desired.

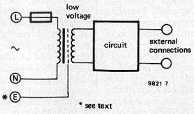
Some types of transformer do not employ split-bobbin construction, but have both windings on a single bobbin in layers. Since the insulation in this case consists only of the enamel on the winding wire and thin paper or plastic interleaved between the windings, this type of construction is much more prone to insulation breakdown. This type of transformer should be provided with an interwinding screen, which is a layer of metal foil between the primary and secondary winding layers. This screen is earthed, thus forming a barrier between the primary and secondary windings. Any insulation breakdown will reach the screen before it reaches the secondary winding, causing a large current to flow to earth and thus blowing the fuse in the live lead. An example of this type of construction is given in figure 9. If a metal case is used it must also be connected to mains earth. This type of circuit must always be used with the earth lead connected to the earth terminal of a three-pin mains plug.

Additional protection against electric shock due to the housing of equipment becoming live may be provided by having an earth leakage circuit breaker fitted to the house wiring. Any current flowing to earth will cause the circuit breaker to trip and disconnect the mains supply.

To summarise, electrical equipment can be made safe from a shock hazard point of view in several ways:

1. Any equipment in which high voltages are present should be suitably housed so that high-voltage points cannot be touched.
2. Protection against the housing becoming live should be provided in one of three ways:
    a. The housing may be of insulating material.
    b. The housing may be of metal, in which case it should be earthed.
    c. The housing may be of metal and not earthed, in which case the high-voltage sections of the circuit should be double-insulated from the case.
3. If the circuit has external connections then the supply to the circuit must come from a transformer with separate primary and secondary windings. Care should be taken to avoid any high-voltage points coming into contact with the low-voltage section of the circuit. To this end a double-insulated transformer or a transformer with an earthed interwinding screen should be used. The high-voltage wiring should also be double insulated or physically separated from the low voltage circuits. If double insulation and a double-insulated transformer are employed then the case, if metal, need not be earthed. If double insulated construction is not employed then the case should be earthed, if metal.

7



8

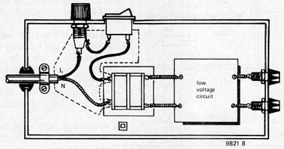


Figure 8. If double-insulated construction is employed, no earth lead need be provided. Care must be taken to ensure that no high-voltage point can contact the low-voltage circuit.

9

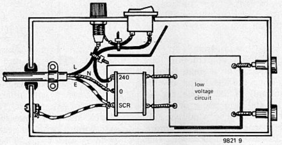


Figure 9. A single insulated transformer with interwinding screen requires an earth connection to the screen. Care should be taken to ensure that no high-voltage point can contact the low-voltage circuit. This can be achieved by physical separation of the high- and low-voltage circuits and clamping of leads to ensure that no contact can occur, by a physical barrier, or by double insulation of the high-voltage circuit.

Fire hazards

Overheating of equipment can lead to fire hazards, since many of the plastics used as insulators in electronic components and assemblies are inflammable, as are wooden and plastic cabinets. Overheating usually occurs in one of two ways, either through inadequate ventilation under normal operating conditions, or through excessive current flow caused by a circuit malfunction or misuse.

Overheating due to inadequate ventilation is prevented simply by providing ventilation holes and/or cooling fans in equipment that produces a significant amount of heat. In commercial equipment, protection against excessive current flow may be provided in a variety of ways, but for the home constructor the humble fuse fulfils most needs.

The simplest form of protection is provided by a fuse in the live lead of the mains input. This fulfils two functions. If a live to neutral short-circuit occurs at any point in the circuit after the fuse, or any other malfunction occurs which causes excessive current flow then the fuse will blow.

If the equipment is in an earthed metal case the fuse will also blow in the event of a live to case short, thus preventing an electric shock hazard. Fuses may also be used in other parts of the circuit to protect particular sections (for example each channel of a hi-fi amplifier may have a fuse in the supply line) but these should be in addition to the mains fuse.

The ideal place for the mains fuse is in the mains plug, since it then also protects the mains lead to the equipment. However, this is not always feasible for several reasons. Firstly, the domestic wiring may not be suitable for plugs of the 13 A fused type. Secondly, the minimum rating of fuse available for this type of plug is 2 A, which may be too high if only a low-power circuit is to be protected. In this case a fuse of suitable rating should be installed inside the equipment.

So that the fuse does not blow during normal operation of the equipment, its current rating must be greater than the maximum current consumption of the circuit. The current rating of the fuse must not be too great or it may not provide adequate protection. On the other hand, if the fuse rating is too close to the normal current consumption of the circuit it will eventually fail in normal operation due to premature ageing caused by the heating effect of the current flowing through it. ◆

NEW PRODUCTS

Electronic Multimeter

K. P. Electronics have developed muiltimeters having input sensitivity of 500 K ohms/Volt, working on two battery cells of 1.5 V each. It has a flat frequency response from 10 Hz to 100 KHz and indication up to 1MHz. This meter measures VOLTAGES (AC/DC) from 2 millivolts to 30KVolts, CURRENT (AC/DC) from 20nanoamps. to one ampere, RESISTANCE from 20 milliOhms to 30MOhms, frequency from 10Hz to 100KHz, CAPACITANCE from 2pF to 10,000uF, INDUCTANCE from 10mH to 10Henery, POWER from 10mW to 30 Watts and TEMPERATURE from 0°C to 100°C and TRANSISTOR parameters such as ICBO, ICEO, BETA UP TO 1000. with the help of 10 adaptors. All adaptors are mains operated and compact in size.

K. P. ELECTRONICS • B23/204, Anand Nagar • Chh. Shivaji Road • Dahisar (East) • BOMBAY-400 068.

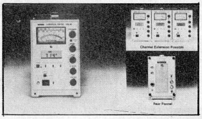
Vibration Meter

M/s. Rion Co. Ltd. of Japan introduces a multi-purpose vibration meter VM-80.

This meter has a wide measurement range. It can measure acceleration from 0.01 to 10,000 m/s^2 RMS, velocity from 0.02 to 10,000 cm/s RMS and displacement from 0.0017 to 10,000 mm (1 mm = 1000 microns) EQ -p-p. It has built in High and Low pass filter for selecting a particular band of frequancies and eliminating unwanted noise. It has two simultaneous displays namely analogue and digital.

The meter can be upgraded/expanded to make it a 3 channel measurement system or by connecting an analyzer, it can become an analysis system for doing extensive analysis. It operates on 4 x 1.5V batteries or optionally by a.c. using an adapter. it weighs 2 kgs.

The equipment is available on Rupee payment basis or on foreign exchange as desired.



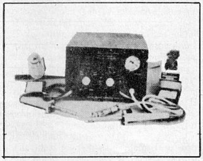
M/s. Mecord Marketing Pvt. Ltd. • 304, Hill View Industrial Estate • Ghatkopar (West) • Bombay-400 086.

Solder/Desolder Station

M.R.K. Engineers have developed a soldering/Desoldering Station indigineously, for rework on C-MOS, FETS etc., as well as for production line and laboratory work.

The system comprises of a soldering and a desoldering section. The Soldering section has been provided with a digital display for easy setting of temperature. The desoldering station is equipped with temperature controlled Solder Station & Finger/Foot operated vacuum pump.

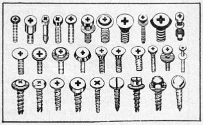
The unit is designed to operate on 230 V ± 20%, with Soldering Iron power of 50 W ± 10% and temperature, adjustable from 170°c to 450°c.



M/s. M.R.K. Engineers • 304, Paradise Apartments, • Shantinagar • Road No. 27 • Wagle Estate • Thane-400 604.

Components for Electronics Industries

PIC have developed a wide range Philips Recessed cross stat punch machine screws and self tapping screws. The screws are as per IS, DIN and JIS standards. 965, 7987, 7995, 7996.

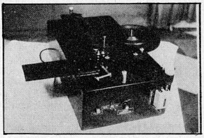


M/s. Precision Industrial Components • F-Marine House • 11-A, Navroji Hill Road • P.B. No. 5153, Chinch Bunder • Near Sandhurst Road Rly. Stn. • Bombay-400 009. Ph: 861213 & 8724815.

Universal Computer Ribbon Stuffing Machine

TRACK ENGINEERS, Bombay has recently introduced a ribbon refilling machine for computer printer ribbons. The machine is useful for filling the new ribbon from ribbon rolls into the cassette.

The machine consists of a variable speed drive rotating at speed of 300 rpm with a speed controller and a revolution counter. Normal time required for stuffing one cassette is 2-3 minutes. The variable ribbon guiding arrangements makes it possible to use different sized ribbon rolls.



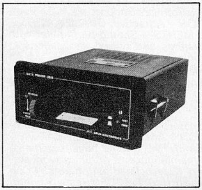
M/s. Track Engineers • 209, Devendra Industrial Estate • Lokmanyanagar • Pada No. 2 • Thane (W)-400 606. • Ph: 50 94 46.

24 Column Printer

ARUN offers 24 Column Alpha Numeric Printers fitted with Epson mechanisms.

The Speed of the printing is 0.5 lines per sec. It is a 5 x 7 Dot Matrix Printer. This EPSON Printer has 24 column and it is supplied with electronic interface which can accept 8 bit parallel input confirming to centronics specifications 2500 cps maximum, or asynchronous serial input TTL level 1200 ro 2400 bauds selectable. Printer and Interface cards are housed in a small cabinet, which needs 5V DC supply for operation.

This printer is useful to manufacturers of Process Control Instruments, Weighing Machines, Cash Registers, Computers, Microprocessor based system, etc. etc.



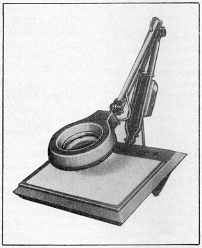
M/s. Arun Electronics Pvt. Ltd. ● B/125, Ansa Industrial Estate ● Saki Vihar Road ● Sakinaka ● Bombay-400 072. ● Tel: 583354/587101.

Lensel's high-quality illuminated magnifier

Electronics companies can now avail of the best illuminated magnifier in India for PCB assembly and inspection – the Magnavision Deluxe (transmitted light-model). Manufactured by Lensel Optics, a leading Pune-based company, the magnifier is used by all the big companies like BEL, BHEL, Bajaj Auto, Meltron, Nelco, Philips India and Videocon, to name a few.

The Magnavision Deluxe's lighted area, 405 mm x 285 mm, can cover PCB's of all sizes. A 127 mm main lens gives distrotion-free x 4 area magnification. In combination with an attachment housing a 55 mm lens you can get x 10 magnification. Two 22 W circular fluorescent tubelights give cool, glare-free illumination. A transmitted light box enables through light inspection and assembly of transparent and transulcent objects; e.g PCB's gang condensers, artworks, negatives etc. The magnifier is also useful for track checking and flu cleaning.

The model comes with three types of bases : heavy CI, movable and bolting type.



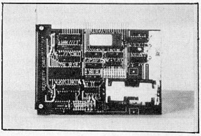
Magnavision Division, Lewnsel Pctics Pvt. Ltd. ● 66/2, D II Block ● MIDC Area ● Chinchwad ● Pune-411 019.

Hardware Security

IBM has realized the importance of hardware based password security in PCs and have incorporated this in their new PS-2 models.

Real Time Systems offers Hardware Security Systems through which one can restrict the number of users using the computer and keep the unauthorized users at bay.

The system consist of an add-on card which allow booting only if the correct password is given.



The security system can maintain as many as 40 users.

Besides the password, the system also maintains the log of the users.

This unit can be installed in all the IBM-PC, XT, AT and 386-AT machines with DOS 3.0 or higher, without any modification.

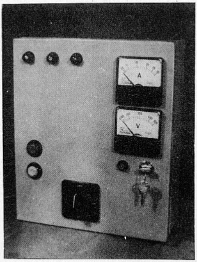
Real Time Systems ● Plot No. 8, 4th Main Road Avenue ● Opp. Viswabharathi School ● Dhandeesvarar Nagar ● Valachery ● Madras-600 042.

Indoor/Outdoor Submersible Pump Panel.

AMEYA Electronic & Appliances manufactures Direct-On-Line (DOL) panels from 1 H.P. to 7.5 H.P. 3 phase and Star Delta Panels from 5.00 H.P. to 15 H.P. – 3 phase, for submersible Pump motors.

These panels feature fully electronic protection systems such as single phase, unbalancing overload & reverse phase protection, time delay auto restart facility & dry run protection.

These panels start the pumps automatically when the power supply is OK.

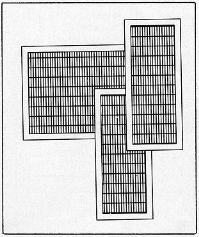


M/s. Ameya Electronic & Appliances ● S.No. 10/2, Block No. 10 ● Shrikrishna Weaving Mills Compound ● Vengurla Road ● Hindalga ● Belgaum-591 108.

NEW PRODUCTS

Solar Photo Voltaic Battery Charger

B & H have introduced a SOLAR BATTERY CHARGER which can be used in Automobiles, Boats, Mobile wireless sets and other places where Batteries are used. The SOLAR CHARGER helps in protecting and additional topping up of Batteries during idle and non-use period of Vehicles, against self discharge. This extends the Battery life. It also helps in addition of power during use of Air-Conditioner, Radio, Tape recorder etc. in the vehicles. The unit has a life span of 20 years and is totally maintenance free. Availe in 6 Volts, 12 Volts & 24 Volts outputs to suit almost all sorts of Batteries.



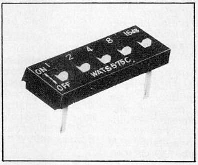
M/s. B and H Integrated Services • 89, 16 'C' Main, 4th Block • Koramangala • Bangalore 560 034. Ph: 34 91 76 (0812)

Digital Attenuator Dip Switches

OTAX Company Limited, Japan, has introduced the 'W' Series Digital Attenuator DIP Switches. This is a PC mountable DIP type Digital Attenuator, TWO-IN-ONE low profile complex device, consisting of slide actuated DIP Switch and thick film resistor network which provides high reliability and performance.

These switches reduce the production cost because the resistor network is incorporated inside the housing, Other features include environmental sealing for resistor network because of "moulded in" feature, reliable and stable contact because of high contact pressure (200 Kg/mm^2), suitability for Auto-insertion, Auto-soldering and Auto-cleaning.

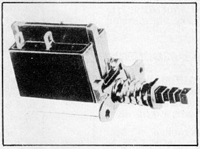
Impedence of the Attenuator available are 50, 75, 150, 300 and 600 ohms at frequencies of 30, 5, 1 MHz, 200 and 600 KHz respectively. Attenuation range is in the steps of 0.5 dB, 1.0 dB, 2.0 dB, 4.0 dB, 8.0 dB and 16.0 dB. Rated input power is 50 mW.



M/s. Hi-Tech Resistors Pvt. Ltd. • C/o. N.G.D.A. & Service • Mount Road (Extension) • Nagpur-440 001.

Switches for T.V.

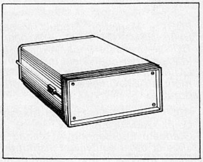
'RGK' brand Push On-Push Off Power Switch, Double Pole, has been developed for use in Televisions. Rated at 5A, 250V and surge capability of 100A, with mechanical/electrical life 20,000/10,000 cycles. Besides, 'RGK' also offers a range of high quality switches for other applications which are already being used by O.E.M's of Electrical & Electronic equipment all over India, other Asian countries and in Europe.



M/s. Indian Engineering Company • Katara Mansion • Post Box 16551 • Worli Naka • Bombay-400 018.

Instrument Cabinets

System Engineering offers Instrument Cabinets suitable for standard DIN Panel cutout. Various instruments cabinets to suit panel cutout of 92 x 92 mm, 138 x 67 mm, 186 x 92 mm, 92 x 45 mm, 67 x 67 mm, 138 x 138 mm, and 186 x 186 mm are available. Each model is available in 80, 120, 160, 200, 250 and 300 mm depth.

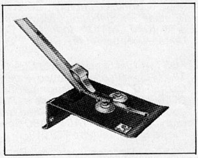


M/s. System Engineering • 38-39, Hadapsar Indl. Estate • Pune • Maharashtra-411 013. Ph: 670962 & 671951.

Dip IC Lead Straightner

IC Lead Straightner Automatically Align IC Leads to Facilitate stuffing of Dip IC's into printed circuit boards. Leads and Formed to precisely match the hole spacing in the PCB. The Models IS-31, IS-32 and IS-33 accept all standard 8-40 pin Integrated Circuits including Mos and C Mos devices on 0.300", 0.400" and 0.600" Centres respectively.

Simply attach full Tube of IC's and then slide IC's through forming rollers.

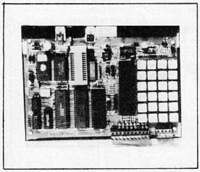


M/s. Time Engineers • F-17/1, M.I.D.C. Area • Chikalthana • Aurangabad 431 210. (M.S.)

NEW PRODUCTS

uP Trainer Kit

This Kit is designed to understand and explore Software and Hardware features Microprocessor The 8085-A. It has 8K (16k optional) Monitor Eprom, Two 8155, 2K (8K expandable) CMOS RAM with battery backup. It has built in Eprom Programmer which can program 2716, 2764, 27128. The Eprom Programming is on line. It has single key operation for Block move, Block compare, Block program. Beside this it has real time clock, facility for serial communication. It has all the features of SDK-85 program. Detailed and easy to understand manual is provided with listings. The kit will be useful for students, engineers, and hobbyist who wants to do projects with microprocessor.



M/s. New Age Electronics • 9, Laxmi Mahal • Near Vandana Cinema • Opp. Bhatia compound • Agra Road • Thane-400 602.

Thermistors

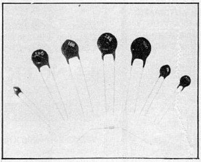
UNIZON CORPORATION – Japan manufacturers a wide range of thermistors viz. Power, NTC sensors, Disc, Chip and Glass Encapsulated (DHT) Thermistors.

POWER THERMISTORS feature high stability, reliability and is epoxy coated for applications in SMPS, TV monitors, Motirs etc. DISC THERMISTORS are lacquer coated for high stability. They can be used for temperature detection and compensation in control equipments, radios and instruments.

GLASS ENCAPSULATED THERMISTOR (DHT) are of small size, light weight and hermetically sealed for specific applications such as temperature sensors in the chemical and food processing industry.

CHIP THERMISTOR features small size, quick response time which is mainly suitable for clinical thermometers.

The NTC THERMISTOR SENSORS meet the industrial requirements of high reliable electronic temperature control system in conventional Airconditioners, Cold storage refrigeration and boiler equipment.



A.T.E. LIMITED • Electronic Division • 36, SDF II, SEEPZ • Andheri (East), Bombay-400 096.

Temperature Indicator

The Mantemp 786-92A is a multi channel (i.e. 8 channel). Temperature Indicator available in Bench and Panel mountings with front Panel button channels and temperature (°F and °C) selector switches.

Features:
Range: 1) -50°C to 1200°C and -58°F to 2192°F
2) -50°C to 200°C and -58°F to 392°F

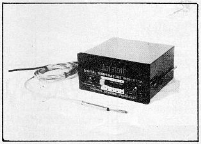
Resolution: 1°C or 1°F

Accuracy: ±0.5% of full scale span.

Power: Mains 230 AC 1-∅ 50Hz.

Probes: Al/Cr or Pt 100, with rear mounted sockets.

Ambient compensation: 0 to 50°C for A/C sensors.



M/s. Thermal Sensors • 37 A, Electronics Complex • Kushaiguda • Hyderabad-500 762.

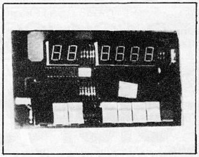
Memory Timer

The Timer microprocessor based and derives basic time from a crystal to the tune of 6MHz with 99 memory time settings. Time is displayed on 4 seven segment displays, and the location address by an other 2 seven segment displays.

Time setting is done by individual switches which work as Incremental Electronic thumb wheel switches. Every time the memory address is changed, the contents are stored. Upon recalling the set time, the system can count down to zero on manual request engaging a relay for this period. After the time lapse, the system reloads the pre-set value.

Different versions are available for base time, with seconds, minutes, hours, and any fraction the user needs. Sequential timing is also possible on this timer.

Made for direct panel mounting it and operates on 5 Volts, it retains Memory with 10uA battery backup.



M/s. Jacobs Industrial Products • a unit of Jacstech (P) Ltd • No. 117A, M.G Road, Pondicherry-605 001.

Bridge Rectifiers

Darshan Enterprises manufactures miniature single phase Bridge Rectifiers in small packages. The range starts from 1 A(50 to 800 PIV) and goes up to 5 A)50 to 800 PIV). The packages are in square and vertical type to suit individual requirements. More varieties of higher ampere ratings of 6 A, 10 A and 25 A (50 to 1000 PIV) are under development.

M/s. Darshan Enterprises • 317/8, Kastur Kunj • Sir Bhalchandra Road • Matunga • Bombay-400 019.

R. N. No. 39881/83

Allowed to post without prepayment. LIC No. 91

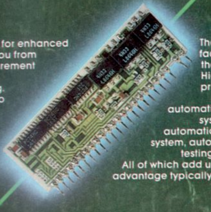
MH BY WEST-228
LIC No. 91

Get the ECIL advantage!

Tap the dedicated design group to develop the working hybrid you need

Besides the size and weight reduction for enhanced portability, Hybrid Microcircuits free you from chores involving layout design, procurement of components, inspection, inventory planning, population and final testing. A series of steps that invariably go into the making of a microcircuit.

ECILs dedicated design group aided by CAD facility can help you develop the working hybrid you need. Be it in telecommunications or computers or what have you.



The manufacturing facilities are about the best anywhere: High speed screen printing machines, computerised automatic laser trimming system, high-speed automatic pick and place system, automatic functional testing equipment, etc. All of which add up to give you the advantage typically ECILs. Technical or commercial.

ECIL
Hybrid Microcircuits

For enquiries, contact:
Marketing Manager, Sales II
इलेक्ट्रानिक्स कारपोरेशन आफ इण्डिया लिमिटेड
Electronics Corporation of India Limited
(A Govt. of India — Dept. of Atomic Energy — Enterprise)
Components and Special Products Group
Hyderabad-500 762
Phones: 850131 Extn: 258, 853831
Telex: 0425-7059

ASP/ECIL/88111